Chapter 2 Analysis of Existing Geologic Information

2-1 Purpose of Analysis

It is intended to outline ore deposits and indications in the survey area and to grasp occurrence of minerals, by means of collecting, sorting out and analyzing existing data. are listed in the Reference at the back of this volume.

2-2 Geology

The explanatory notes to the 1:100 000-scale geologic maps (Serie A) covering the survey area were published from 1978 to 1994; however, the maps are not necessarily consistent to each other. The INGEMMET commenced implementing the seven-year program called "Estudio de Recursos Minerales por Franja" in the year 2000, starting with the southern region. The study, currently underway, is intended to make the existing maps consistent. The survey area is included in the 2001 study area (Franja 2), of which regional correlation of geologic stratigraphy has been made, as well as description of ore deposits and indications. This Report is based on the geologic units as classified in the mentioned study program but, when necessary, correlation is made to the geologic units in the existing maps, as well. An outline of the stratigraphy is that Precambrian to Quaternary sedimentary rocks and their metamorphics lie stretching in the NE-SW direction, and Ordovician to Silurian, Cretaceous to Paleogene and Neogene intrusive rocks intrude into these rocks. The southwest to east part of the survey area is underlain by the Precambrian rocks, which are gradually replaced by sedimentary rocks of younger ages toward the northern part.

In the following paragraphs, descriptions on the metamorphic, sedimentary and intrusive rocks are given in chronological order, in accordance with the newly established stratigraphic division (Fig.13). The codes following the respective geologic units conform to the uniform codes used in the newly compiled the geologic units.

2-2-1 Precambrian

(1) Coastal Basal Complex (PeB)

The coastal basal complex is composed of a variety of metamorphic rocks lying along the coastline in the southwest of the survey area, which include gneiss, augen gneiss, migmatite, crystalline schist, phyllite, amphibolite and quartzite. In mylonitized zones, gneissosed alkali granite is distributed.

The Rb-Sr dating indicates 1424±70 m.y. and 1307±65 m.y. for gneiss, 809±40m.y. for granite undergoing some textural deformation, 907±45 m.y. for amphibolite, 681±30 m.y., 631±30 m.y. and 540±27 m.y. for mylonitized granite (augen gneiss), respectively. [Caldas, 1978]. These measurements are interpreted to indicate respective source rocks, intrusion time and granite deformation time.

The regional metamorphic rock bodies spotted along the Majes-Colca Rivers in the east of the survey area had initially been included in the Coastal Basal Complex but were later reclassified by Caldas in 1993 as the Majes-Colca Complex, since the rock bodies are situated within the inner zone in relation to the general trend of the Andean geologic units and the direct relationship between the rock bodies and the Coastal Basal Complex remains unclear. In the survey area, the subject rock bodies lie in the northwestern extension of those lying along the Majes-Colca Rivers as the type locality; therefore, the bodies were reintegrated into the Coastal Basal Complex. The component rocks are dioritic to tonalitic gneiss, granitic gneiss, meta-sediments, amphibolite, migmatite, etc.

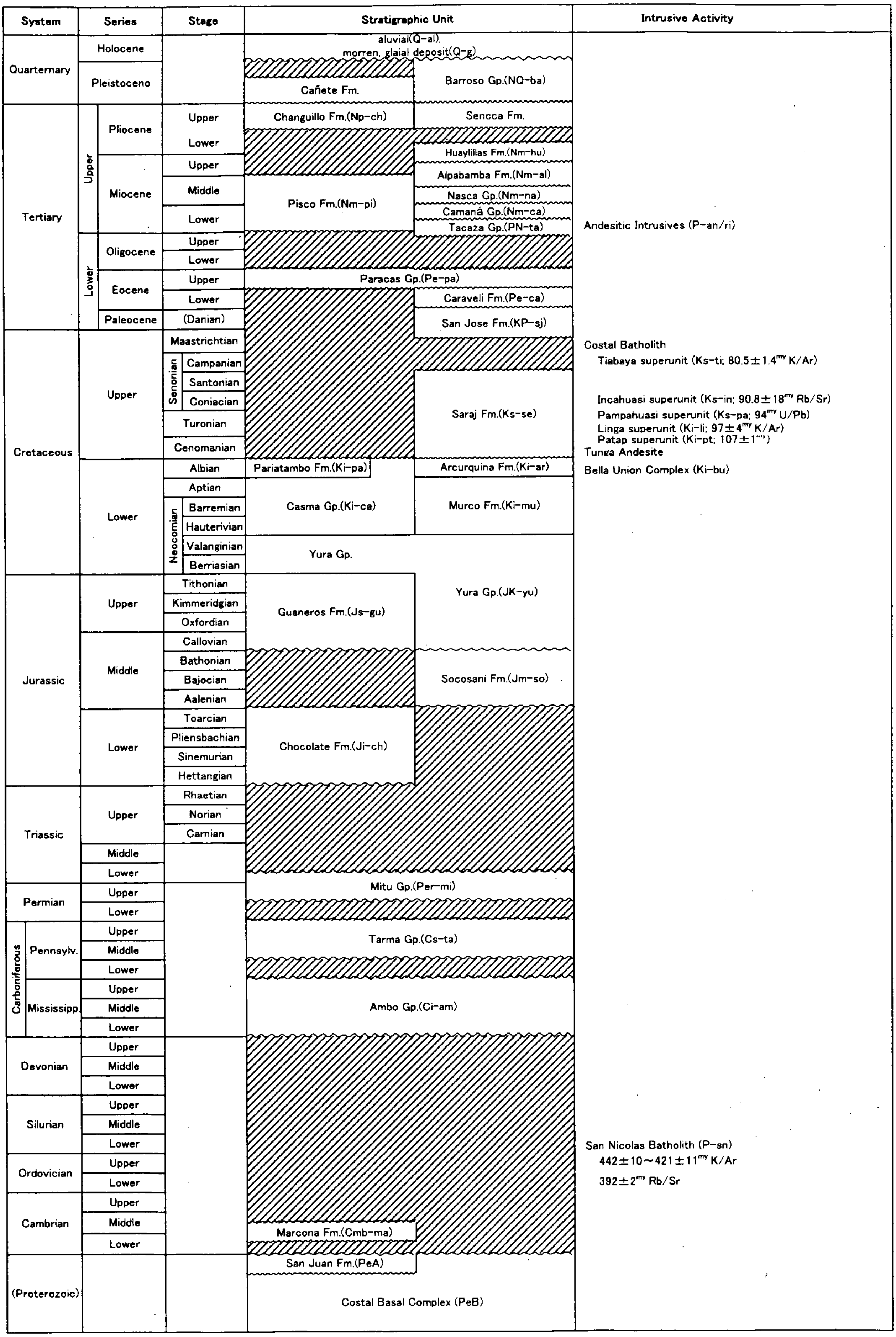


Fig.13 Schematic geologic column

The dioritic to tonalitic gneiss has foliation of white portions composed of quartz-feldspar and mafic minerals portions mainly of biotite-sericite, and intensively folded internal texture is observable. Granitic gneiss is generally coarse-grained, occasionally looking like augen gneiss with megacrystals of quartz-feldspar. The meta-sediments are greenish gray and fine-grained, associated with amphibolite composed of medium-grained chloritized hornblende and light-colored migmatite. Various intrusive rocks, such as alkali granite, basic to neutral dikes, and pegmatite abundant with small platy garnet, intrude into them. The alkali granite is gneissosed.

(2) San Juan Formation (PeA)
This Formation unconformably (angular unconformity) overlies the Coastal Basal Complex. The Formation is lithologically subdivided into three members. The lower member is generally of calcareous rocks, marbleized and, at around its basement, consists of a banded horizon composed of grayish to light pink-colored calcareous schist, while thick beds of yellowish white-colored, dolomitic marble gradually increase upward. The middle member is generally composed of pelitic rocks partially changing to low graded schist. Its lower horizon is composed of grayish white sericite schist while the upper horizon consists of bluish green chlorite schist. The upper member is composed of fine-grained, white dolomitic limestone which is intensively brecciated structural cataclasite.
Intrusive rocks of the San Nicolas Batholith intrude into the Formation.

2-2-2 Paleozoic Erathem

(1) Cambrian System
1) Marcona Formation (Cmb-ma)
The Formation unconformably covers the underlying formations such as the Coastal Basal Complex and the San Juan Formation. Dolomitic marble pebble and hornfelsic conglomerate with calcareous crust are distributed in the basement, which is thickly underlain by silicified sandy limestone. The limestone intercalates phyllitic hornfels, bluish to dark gray-colored quartzite, chlorite schist partially impregnated with limonite, phyllite, etc. Brecciated crystalline limestone is also distributed.
Intrusive rocks of the San Nicolas Batholith intrude into the Formation.

(2) Carboniferous System
1) Ambo Group (Ci-am)
The Group is made up of dark gray to black, fine-grained sandstones which intercalate calcareous shale including a great deal of fossil flora, greenish gray sandstones which intercalate carbonaceous shale to thin coal layers including fossil flora, phyllitic black shale, dark gray siltstone, dark gray to black limestone, etc. The Group rests unconformably upon granites of the lower Paleozoic granites, and is correlated with the lower Carboniferous due to the presence of fossil flora.

2) Tarma Group (Cs-ta)
The Group unconformably overlies the Coastal Basal Complex and is unconformably underlain by the Mitu Group. The Tarma Group is made up of greenish gray mudstones accompanied by fine veinlets of calcite and epidote, thin beds of yellow to orange shale, dark gray siltstones intercalating greenish gray fine-grained sandstones and gray silicified limestone, greenish gray phyllitic bedded shale with dark gray limestone, and green sandstone which intercalates gray limestone containing a great deal of fusulina and coral remains. Conglomerate beds including limestone gravel are occasionally embedded.
In view of the contained coral, the Group is correlated with the upper Carboniferous.

(3) Permo-Triassic System

1) Mitu Group (Per-mi)

The Group, unconformably overlying the Tarma Group, is composed of arkose and arkosic sandstones. The arkosic sandstone is dark gray to red, fine- to medium-grained and poorly sorted, while the arkose is composed of orange, coarse-grained, angular feldspar-quartz grains. These exhibit the characteristics of continental sediments transported over a short distance.

2-2-3 Mesozoic Erathem

(1) Jurassic System

1) Chocolate Formation (Ji-ch)

The Formation lies in the coastal zone, unconformably covering the coastal basal complex or the Tarma Group. It is subdivided into the Chala Member in the lower part and the Lucmilla Member in the upper part.

The Chala Member is made up chiefly of sedimentary rocks, mainly greenish gray, fine-to medium-grained sandstones intercalating green conglomerate and gray, greenish gray to green andesite or trachyandesite. Volcanic rocks increase upward. At around the basement, several layers of iron ore such as magnetite, specularite and limonite are embedded.

The Lucmilla Member is composed mainly of volcanic rocks, mainly brown porphyritic andesite accompanied by reddish brown to purplish brown andesite, dacite, volcanic breccia, rhyolite, latite, etc. No fold structure is observable in the Formation, while it has a monoclinal flexure striking E-W ~ N60°E and dipping 10°-20°N.

In the light of the fossil brachiopods contained in the green to greenish gray sandstones of the Chala Member, the Formation is correlated with the lower Jurassic.

2) Guaneros Formation (Js-gu)

The Formation lies in the coastal zone and disconformably (erosional unconformity) covers the underlying Chocolate Formation. The top of the Guaneros Formation grades into the Yura Group.

The lower horizon consists of alternation of gray mudstones, light gray sandstones and platy, fine-grained pyroclastic rocks intercalating gray to light gray banding chert. White quartzitic sandstone is increasingly dominant upward. The upper horizon is mainly composed of dark gray to greenish gray, massive to platy andesite accompanied by andesitic volcanic breccia with sediments, intercalating light gray chert, fossil-rich, dark gray marl and, occasionally, weakly recrystallized, gray, light gray to yellowish gray limestone which contains fossils. The horizon rarely intercalates light gray to white quartzitic sandstones, which somewhat increase in the upper part.

In the light of the presence of fossils, the Formation is correlated with the upper Jurassic (Portlandia-Tithonian).

3) Socosani Formation (Jm-so)

The Formation appears in mountains. While its basement is unknown, its top is disconformably covered by the Yura Group. The Formation is chiefly made up of grayish yellow marlitic limestone, nodule-rich, dark gray, bituminous limestone, calcareous black sandstone including limestone nodules, intercalating oolitic limestone with chert, sandstone, slate and andesite.

Due to the presence of fossils, the Formation is correlated with the middle Jurassic (Dogger).

4) Yura Group (JK-yu)

The coastal zone in the west and the mountainous zone in the east of the survey area differ in the stratigraphic position of this Group. In the mountain zone, the Group is made up of clastic rocks of late middle Jurassic to early lower Cretaceous, and is subdivided into five formations whereas, in the coastal zone, it is composed of those of late upper Jurassic to early lower Cretaceous.

In the mountainous zone in the east of the survey area, the Group disconformably covers the Socosani Formation and represents monoclinal structure striking NW-SE and dipping NE. It is subdivided into five formations, the top of which grades conformably into the Murco Formation. These formations are enumerated in ascending order, as follows:

① Puente Formation; Composed mainly of yellowish to greenish sandstones, intercalating thin layers of dark gray, carbonaceous shale. Correlated with the lower to middle Callovian-Oxfordian.

② Cachios Formation; Composed mainly of dark gray shale intercalating thin beds of sandstone and beige mudstone; it yields ammonite-bearing nodules; correlated with the lower Oxfordian.

③ Labra Formation; Composed of light gray sandstones which assume pinkish to yellowish colors if weathered; carbonaceous shale beds containing fossil flora are intercalated in the lower horizon while, in the upper horizon, gray to black siltstones are embedded; correlated with the Tithonian-Berriasian.

④ Gramadal Formation; Composed mainly of blackish gray limestone, the Formation intercalates purplish shale; it yields abundant fossil splinters of gastropods, coral and ammonites; correlated with the Kimmeridgian-Neocomian

⑤ Hualhuani Formation; Composed of white, quartzose and fine- to medium-grained sandstones. Cross-bedding develops; the Formation assumes yellowish to reddish colors if weathered; the grain size is coarser upward, grading into fine-grained conglomerate at the top; although accurate correlation of age has not been established as the Formation yields only splinters of fossil plants (stems). It is stratigrafically correlated with the lower Cretaceous.

In the coastal zone in the west of the survey area, the basement conformably overlies the Guaneros Formation, while its top grades conformably into the Casma Group.

The lower horizon is chiefly made up of white-, light gray- to gray-colored, fine-grained sandstones to quartzitic sandstones, cross-bedded, which assume brown to dark red colors if weathered due to oxidation of iron content. It intercalates gray to dark gray siltstones to shale, and limestone to sandy limestone, etc. and is occasionally accompanied by intercalations of black, andesitic pyroclastic rocks.

The upper horizon of the Formation is made up of gray, light gray to white sandstones, quartzitic sandstones and graywacke sandstones, and is cross-bedded. As compared with the lower horizon, it has lesser intercalated layers in terms of quantity and thickness, having no limestone. Gray siltstone and shale are embedded.

The Formation, correlated with the Tithonian-Aptian, is interpreted to correspond to the Gramadal Formation-Hualhuani Formation of the Yura Group in the east.

(2) Cretaceous System

1) Casma Group (Ki-ca)

This Group had been classified into the Copara Formation in the coastal zone. As the result of the reviewal of stratigrafical correlation all over Peru implemented as a part of the Estudio de Recursos Minerales por Franja, it was intended to integrate the Group into the Casma Group as described from the north to central part of the survey area. The Group corresponds to the Murco Formation in the mountain zone and also to the overlying Arcurquina Formation.

The Casma Group has conformable relationship with the underlying Yura Group. The lower horizon is composed chiefly of gray to greenish gray, medium- to coarse-grained pyroclastic

sandstones intercalating fine-grained volcanic breccia of the same colors. Gray to greenish gray, andesitic volcanic breccia is increasingly dominant upward. The middle horizon is made up of conglomerate consisting of quartzite pebble and volcanic pebble, whose matrix is yellowish gray and sandy. Toward the top of the horizon, it changes to yellowish, medium- to coarse-grained graywacke-arkosic sandstone, and to alternation of gray to white quartzite, gray siltstone, and andesitic, pyroclastic rocks at the top. Occasionally, it intercalates cherty limestone. The upper horizon is composed mainly of andesitic volcanic breccia intercalating gray limestone, cherty limestone, calcareous graywacke and fine-grained conglomerate.
Though scarce of fossils, the Group is stratigrafically correlated with the Neoconian-Albian, corresponding to the Murco Formation in the mountain zone in the east of the survey area.

2) Pariatambo Formation (Ki-pa)
This had been described as the Portachuelo Formation in the coastal zone of the survey area but was reclassified into the more universal Pariatambo Formation. The Formation is made up of gray to light gray limestone, micritic limestone, cherty limestone and light gray limestone. It abounds in splinters of fossil crinoids, mesogastropods (turritella) and oysters replaced by calcite. It intercalates gray to light gray, fine-grained, calcareous sandstones and is accompanied by purplish gray-colored pyroclastic rocks. It grades upward to banded cherty limestone intercalating greenish gray, medium- to coarse-grained pyroclastic sandstones, occasionally accompanied by volcanic breccia layers.
The Formation is correlated with the middle Albian and corresponds to the Arcurquina Formation in the mountain zone in the east of the survey area.

3) Murco Formation (Ki-mu)
The Formation conformably overlies the Hualhuani Formation of the Yura Group in the mountain zone and grades conformably into the Arcurquina Formation. It is subdivided into three members.
The lower member is composed of dark gray limestone rich in nodules while lacking fossils, and its top grades into red beds intercalating medium- to coarse-grained, white sandstones.
The middle member is composed of purplish red graywacke intercalating greenish gray conglomeratic sandstones, which grade upward to brick red-colored, fine-grained, thinly stratified sandstones.
The upper member changes upward from the underlying gray sandstone with cross-bedding to alternation of red to purplish mudstones-shale and saccharoidal gypsum layers, to alternation of thin siltstone layers, and to dolomitic limestone beds, grading into the Arcurquina Formation. It intercalates olive-colored sandstones accompanied by green siltstones, calcareous sandstones and marl.
The Formation is stratigrafically correlated with the lower Neocomian-lower Albian.

4) Arcurquina Formation (Ki-ar)
The Formation conformably overlies the Murco Formation in the mountain zone and is unconformably underlain by the Seraj Formation. It is subdivided into two members. The lower member is made up of alternation of bluish gray, thin bedded, marlitic limestone and yellowish calcareous sandstones, rarely accompanied by chert nodules. The upper member is composed of intensively brecciated, bluish gray-colored limestone with yellow, red and pink crust and rich in fossil urchins and ammonites, and is accompanied by black-, brown- to beige-colored chert nodules.
The Formation is correlated with the Aptian-middle Albian.

5) Seraj Formation (Ks-se)

The Formation, disconformably overlying the Arcurquina Formation, is subdivided into two members. The lower member has the basement composed of red, coarse-grained sandstones to fine-grained conglomerate and is made up of red to light green, fine-grained sandstones, and alternation of purplish calcareous sandstones and yellowish to reddish, brecciated limestone, intercalating lenticular rock salt and gypsum layers. The rock salt beds were worked in the past. The limestone has some horizons marbleized by intrusion of porphyries. The upper member is constituted by continental sandy clastic beds where whitish gray, hard sandstones are intercalated by alternation of thin layers of red sandstone and siltstone.
In view of the inclusion of gastropods, bivalves and ammonites, the Formation is correlated with the Albian-Santonian.

2-2-4 Cenozoic Erathem

(1) Paleogene System
1) San José Formation (KP-sj)
In the mountain zone, the Formation unconformably covers the Yura Group or the Seraj Formation. Its top is disconformably underlain by the Caraveli Formation. The San José Formation is made up chiefly of mostly reddish, clearly stratified sandstone, shale and clay. It abounds with gypsum veinlets, intercalates conglomerate and is accompanied by a large volume of evaporites. It deposits in shallow lacustrine ambience. The Formation is subdivided into two members.
The lower member is made up largely(80%) of sandstones intercalating siltstones accompanied by gypsum veinlets. Depending on localities, brick red-colored, fine-grained conglomerate is intercalated. The conglomerate intercalates medium- to coarse-grained sandstones. The sandstones are made up of subrounded pebble of feldspar and quartz, whose matrix is argillaceous to tuffaceous, compact and occasionally calcareous. The gravels of conglomerate consist mainly of quartzite, volcanic rocks and intrusive rocks.
The upper member is made up chiefly of sandstones frequently cross-bedded. Compared with the lower member, it is more pelitic and tuffaceous, and is well stratified. It intercalates arkosic sandstones, shale and siltstones of various colors. The upper part of the member is characterized by intercalation of large quantities of gypsum and anhydrite layers and of thin horizons of rock salt and diatomite. The gypsum beds, 2 to 3m thick, are white, or occasionally red, and most commonly observable. The anhydrite is white to semi-transparent, either lenticular or in nodules of 2 to 20 cm in diameter. The rock salt and diatomite are white-colored, 2 to 8 cm thick, intercalated by the shale and siltstones of various colors, and are dominant especially at the upper part. The member, yielding no fossils, is stratigrafically assigned to the late Cretaceous to the early Paleogene age.

2) Caraveli Formation (Pe-ca)
Lying in the mountain zone, the Formation is characterized by molasse corresponding to the first period of the Andean movement. It is subdivided into three members. The upper and the lower members are made up of very brittle, conglomeratic coarse rocks whilst the middle member is composed of hard, stratified clastic rocks intercalating fine-grained conglomerates.
The Cruz Blanca Member is made up of gray to purplish, medium-grained conglomerate consisting of subrounded to rounded pebble. The gravels of conglomerate, 60% of which is quartzite, include porphyries deriving from the Bella Union Complex, limestone, intrusives and the basement rocks. As the calcareous matrix increases upward, the conglomerate hardens.
The Cuno Cuno Member is composed of light gray-, greenish gray-, pinkish gray- to brown-colored tuffaceous shale, fine-grained sandstones and siltstones intercalating thin tuffaceous bedding. It includes thin layers of very hard volcanic ash and glauconite, which intercalate

green sandstones including a great deal of plant splinters as well as fine- to medium-grained conglomerate.
The Altos de Calpa Member is made up of gray to light green, heterogeneous conglomerate consisting of poorly consolidated, poorly sorted and rounded to subrounded pebble. The pebble is mainly of quartzite and volcanic rocks, accompanied by limestone, sandstone, intrusive rocks, gneiss, etc. The matrix is calcareous sand. The upper part intercalates thin tuffaceous layers, while the top is composed of pyroclastic rocks intercalating sandstones and white tuff.
Yielding no fossils, the Formation is stratigrafically assigned to the upper Paleocene to the lower Eocene.

3) Paracas Group (Pe-pa)
The Formation unconformably covers the underlying horizons composed of metamorphic, intrusive and Mesozoic rocks while unconformably covered by the Tacaza Group. The basal horizon is composed of conglomerate of metamorphic, intrusive and volcanic rocks. The matrix is sandy and, occasionally, calcareous. Above the basal horizon, lie yellowish brown-colored argillaceous rocks with cross-bedding, which intercalate in lenticular forms thin shale beds, sandy limestone and thin limestone layers. Toward the middle part, shale is increasingly dominant, which is somewhat calcareous, occasionally altered into purplish brown-colored marl. Lenticular beds of tuff and white diatomite are intercalated. Further upward, intercalations of tuff and white diatomite increase. Greenish gray bentonites, sufficiently thick for exploitation, are present.
Depending on locality, limestone to dolomite nodules are observable, as well as horizons in which gypsum veinlets develop.
In view of the inclusion of gastropods, bivalves, large foraminifers, urchins, cirripedias, diatomite, etc., the Group is correlated with the middle to upper Eocene.

(2) Neogene System
1) Pisco Formation (Nm-pi)
In the mountain zone, the Formation unconformably covers the lower units. The lower part is made up chiefly of yellowish conglomeratic, coarse-grained sandstones intercalating horizons abundant with heavily crushed seashells. Toward the middle part, it changes to yellow, fine-grained sandstones intercalating iron-rich horizons cut by brittle gypsum veinlets, white diatomite, tuff, etc. The middle part is composed of fine-grained sandstone frequently intercalating bentonitic clay and gray to white tuffaceous sandstone, which include large amounts of fossils and microfossils, and is accompanied by concretions of marl, porcellanite and siliceous sandstone. The upper part consists of alternation of tuffaceous, medium- to fine-grained sandstones. Lavas and thin layers of volcanic ash increase toward the top, and sandstones, marlitic limestone, shale and diatomite are embedded. A great deal of fossil foraminifers, diatoms, gastropods, brachiopods and, occasionally, whales are found.
Due to the inclusion of fossil diatoms, the Formation is correlated with the middle Miocene to the lower Pliocene.

2) Tacaza Group (PN-ta)
In the mountain zone, the Group unconformably overlies the Yura Group while unconformably underlain by the Sencca Formation. The Tacaza Group is composed mainly of volcanics intercalting marshy sediments and conglomerate beds at the lower part, and is disconformably subdivided into two members. The lower member is made up of dacitic, white-colored, tuffaceous sedimentary rocks depositing in a spacious lacustrine ambience, which turn yellow by weathering. It changes upward to greenish to purplish, latitic to dacitic breccia and to brown andesitic volcanic breccia intercalating lavas and greenish to purplish porphyritic andesite.

The upper member is made up of a series of volcanic rocks, mainly reddish purple- to dark gray-colored, andesitic, rhyolitic to dacitic lavas, which intercalate pyroclastic rocks such as yellowish white to reddish breccia, ignimbrite and tuffaceous conglomerate.
As the K-Ar dating indicates 29.1±0.3 m.y. for the tuff in the lower member and 18.9±0.4 m.y. for the tuff in the upper member, the Group is correlated with the lower to the middle Miocene.

3) Camaná Group (Nm-ca)
In the mountain zone, the Group lies disconformably over the Paracas Formation while unconformably underlain by the Huaylillas Formation. The Camaná Group is made up chiefly of medium- to coarse-grained calcareous sandstones intercalating fine-grained conglomerates and pyroclastic rocks. The basal horizon is accompanied by white-, yellowish white- to pinkish-colored, hard tuff.
The Group, abundant with fossils but including no standard fossils, is stratigrafically correlated with the upper Oligocene to the lower Miocene.

4) Nazca Group (Nm-na)
In the mountain zone, the Group unconformably covers the Coastal Batholith and the folded volcanic and sedimentary rocks of the Mesozoic or the Paleogene, whilst disconformably underlain by the Alpabamba Formation. The Group is subdivided into two formations.
The lower formation is composed of light gray to light brown polymictic conglomerate whose maximum diameter reaches 20 cm. The matrix is fine- to coarse-grained, poorly sorted, and sandy to tuffaceous, which changes upward to light gray- to whitish-colored, poorly sorted, tuffaceous, fine- to coarse-grained sandstone.
The upper formation, known as the Nazca tuff, is made up of rhyolitic, rhyodacitic to dacitic tuffs. The formation can be subdivided into at least seven units by the presence of horizons of ignimbrite or unconsolidated pyroclastics, mud-flow of pyroclastic materials, and volcanic ash of high specific gravity and large volumes of fragments of rocks and pumice.
As the tuff has been dated as 18.9±0.4 m.y., the Group is correlated with the lower Miocene.

5) Alpabamba Formation (Nm-al)
In the mountain zone, the Formation unconformably overlies the Tacaza Group, while unconformably underlain by the Sencca Formation. The Formation is clearly discriminable in aerial photographs because of its distinctive wrinkled patterns. The Formation is made up of white- to grayish white-colored ignimbritic tuff and bluish gray-colored, dacitic to rhyolitic-tuffaceous sediments occasionally intercalating fine-grained sandstones.
The K-Ar dating of the tuff indicates 13.8±0.3 m.y.; the Formation is correlated with the lower to upper Miocene.

6) Huaylillas Formation (Nm-hu)
In the mountain zone, the Formation covers the Tacaza Group unconformably and the Coastal Batholith and Tertiary marine sediments disconformably. The Formation is composed of gray-, yellowish white- to pinkish gray-colored, dacitic to rhyolitic tuff, accompanied by some lava-flow.
Stratigrafically, the Formation is correlated with the upper Miocene.

7) Sencca Formation
In the mountain zone, the Formation unconformably covers the Alpabamba Formation. Its lower part is made up of yellowish white tuff breccia and lapilli tuff including pumice and glass fragments. The upper part is made up of white volcanic ash whose composition is rhyolitic,

rhyodacitic, dacitic and andesitic. Weathering causes the color to turn brown to reddish.
The K-Ar dating indicates 6.2±0.2 m.y.; the Formation is correlated with the lower to upper Pliocene.

8) Changuillo Formation (Np-ch)
The Formation, appearing in the coastal zone from Ica to Nazca region, conformably covers the Pisco Formation and is unconformably covered by the Quaternary. Its lower member is composed of thickly stratified, fine- to medium-grained and weakly consolidated arkosic sandstones intercalating whitish gray siltstones and mudstones. Lenticular intercalations of conglomerate and intercalation of sandstones and tuff are also discernible. The member is increasingly accompanied upward by greenish to yellowish gray-colored marine sandstones. The upper member is characterized by the continental facies. The basal horizon is made up of well-rounded conglomerate, which is underlain by semi-consolidated alternation of pebble, silty sand and silt intercalating tuffaceous sandstones and tuffaceous siltstones.
The Formation is correlated stratigrafically with the upper Pliocene to the Pleistocene.

(3) Quaternary System
1) Cañete Formation
The Formation, lying in the coastal zone, is generally of continental sediments and is composed of the paleoalluvium. It is made up of semi-consolidated conglomerate consisting of subrounded clastics associated with silty sand and brown, medium- to coarse-grained sandstone, which is poorly sorted and cross-bedded.
The Formation is correlated with the Pleistocene.

2) Barroso Group (NQ-ba)
The Formation lies in the mountain zone and is subdivided into three formations. The lower formation is correlated with the Chila volcanic rocks in Arequipa, made up of light gray to dark gray, andesitic to dacitic lavas which lenticularly intercalate yellowish white tuff breccia to agglomerate. The basal horizon is accompanied by tuffaceous conglomerate including scoria or pumice.
The middle formation, correlated with the Barroso volcanic rocks, is composed of bluish gray to reddish gray andesitic lavas, occasionally containing native sulfur. Depending on locality, grayish sandstones are intercalated. The upper formation, correlated with the Purupurini volcanic rocks, is composed of porous cryptocrystalline lavas with the flow structure.
The K-Ar dating of the Chila volcanic rocks in Arequipa has indicated 2.35 m.y.; the Group is correlated with the upper Pliocene to the lower Pleistocene.

3) Recent sediments
Recent sediments fill out valleys, basins and plains. The survey area is underlain by moraine, glacial sediments and alluvium, as well as pyroclastics originating in recent volcanic activity.

2-2-5 Intrusive Rocks

The survey area is underlain by lower Paleozoic forming the batholith and the latest Cretaceous intrusive rocks, and also by intrusive rocks of the beginnings of upper Cretaceous and Neogene, which can be classified by age and composition, as follows.

(1) San Nicolas Batholith (P-sn)
In the coastal range from the Quad. Ica to the Quad. Chaparra, which covers the western part of the survey area, the Batholith intrudes into the Coastal Basal Complex, the San Juan Formation

and the Marcona Formation, and is underlain by the Ambo Group and/or the Tarma Group.
The rocks composing the Batholith can be roughly classified into the five facies: gabbro to diorite, granodiorite to tonalite, adamellite, granite, granite porphyry to quartz porphyry. The intrusion time approximately conforms to this order. The rock facies of the Batholith changes from basic to acidic.
Gabbro-diorite are greenish gray to dark gray to black-colored and have medium-grained texture, distributed in the form of irregular, small rock bodies. These basic rocks are intruded by granodiorite and adamellite, subjected to thermal metamorphism, and form recrystallized, contact metamorphic zones at the contacts. In case the rocks intrude into gneiss the basement, lamination of mafic minerals concordant with gneissose structure of the gneiss is occasionally discernible.
Granodiorite-tonalite are gray- and pinkish- to reddish-gray colored and have medium-grained equigranular texture or, occasionally, porphyritic texture. The rocks are distributed rather extensively in parallel with the coastline. Weakly aligned hornblende parallel with the lamination of country rocks is observable. Adamellite, granites and porphyries that compose the Batholith intrude into this rock facies.
Granites are light gray to pink to salmon pink to red-colored, and have medium-grained equigranular texture and, occasionally, lamination concordant with gneissosity of gneiss as the basement. Granites is occasionally accompanied by granodiorite as xenolith.
Granite porphyry to quartz porphyry, distributed in the form of small stocks or dikes, are grayish pink to light red to dark reddish brown to black-colored. Porphyries are the youngest of all that intrude into all the component rocks of the Batholith.
The K-Ar dating indicates 442±10.4 m.y. to 438±9.4 m.y. for muscovite obtained from adamellite in Quad. San Juan, and 428±12.2 m.y. to 421±10.9 m.y. for hornblende, while 392 ±2 m.y. is obtained by the Rb-Sr whole rock isochron dating. In the light of these measurements and the stratigraphy, the Batholith has been inferred to be Ordovician to Silurian intrusive rocks.

(2) Mesozoic intrusive rocks
The Mesozoic intrusive rocks can be classified into the Bella Union Complex of the beginning of late Cretaceous and the coastal batholith of the end of Cretaceous. The Bella Union Complex is intermittently distributed, fringing the western borders of the coastal batholith.

1) Bella Union Complex (Ki-bu)
The Complex is composed of andesitic intrusive rocks intruding into the Jurassic to lower Cretaceous and cut by the component rocks of the Coastal Batholith. The rocks intrude into the NW-SE fracture zone formed during the Aptian to Albian, and are considered as the forerunners of the igneous activity of the coastal batholith. Three periods of the intrusion time have been distinguished. The early two are represented by andesitic to dacitic intrusive breccia while the third is made up of dikes of the same composition.
The First Period: Intrusive breccia composed of block-like, angular to subangular pebble spreading most extensively. The pebble is of greenish gray- to purplish gray-colored andesite to dacite, occasionally containing fragments of sedimentary rocks. Cavities formed by selective erosion or weathering develop characteristically.
The Second Period: The same intrusive breccia as that of the preceding period, though smaller in pebble diameter and distributed in narrower areas.
The Third Period: Brown- to purplish-colored, andesitic porphyry, dacite to rhyodacite dikes; thermal alteration makes them to turn gray to green. The dikes have a variety of rock facies, partially chloritized and occasionally impregnated with pyrite.
In the Quads. Palpa and San Juan, a grayish green to greenish gray to brown-colored, small

andesite stock and/or dike is described under the name of the Tunga andesite, which is regarded as the activity after the Bella Union Complex and before the Coastal Batholith. In this Survey, the andesite stock and/or dike is included in the Complex. In the Quad. Chuquibamba, a small stock of dacite to rhyodacite, which intrude into and skarnize the Socosani Formation and underlain by the Barroso Group, is described as the Pampachacra dacite. It is mentioned that though there are no grounds for age determination, the body is regarded as of the same age as the Bella Union Complex; in this Survey, therefore, the body is included in the Complex.
Formation of the Complex has been inferred that brecciated bodies were first formed by stoping of semi-consolidated intrusive bodies, then intrusion of small stocks accompanied by contamination or assimilation took place and, finally, dikes intruded into irregular fissure systems of the country rocks. In the area of the Complex, a variety of ore deposits and indications are distributed. Above all, copper mineralization is remarkable; it has been inferred that dikes of the third period are concerned with the mineralization.
In view of the fact that the dikes intrude into the lower Cretaceous Copara Formation and Portachuelo Formation while pierced by the component rocks of the Coastal Batholith, the intrusion has been inferred to take place in the beginning of the late Cretaceous age.

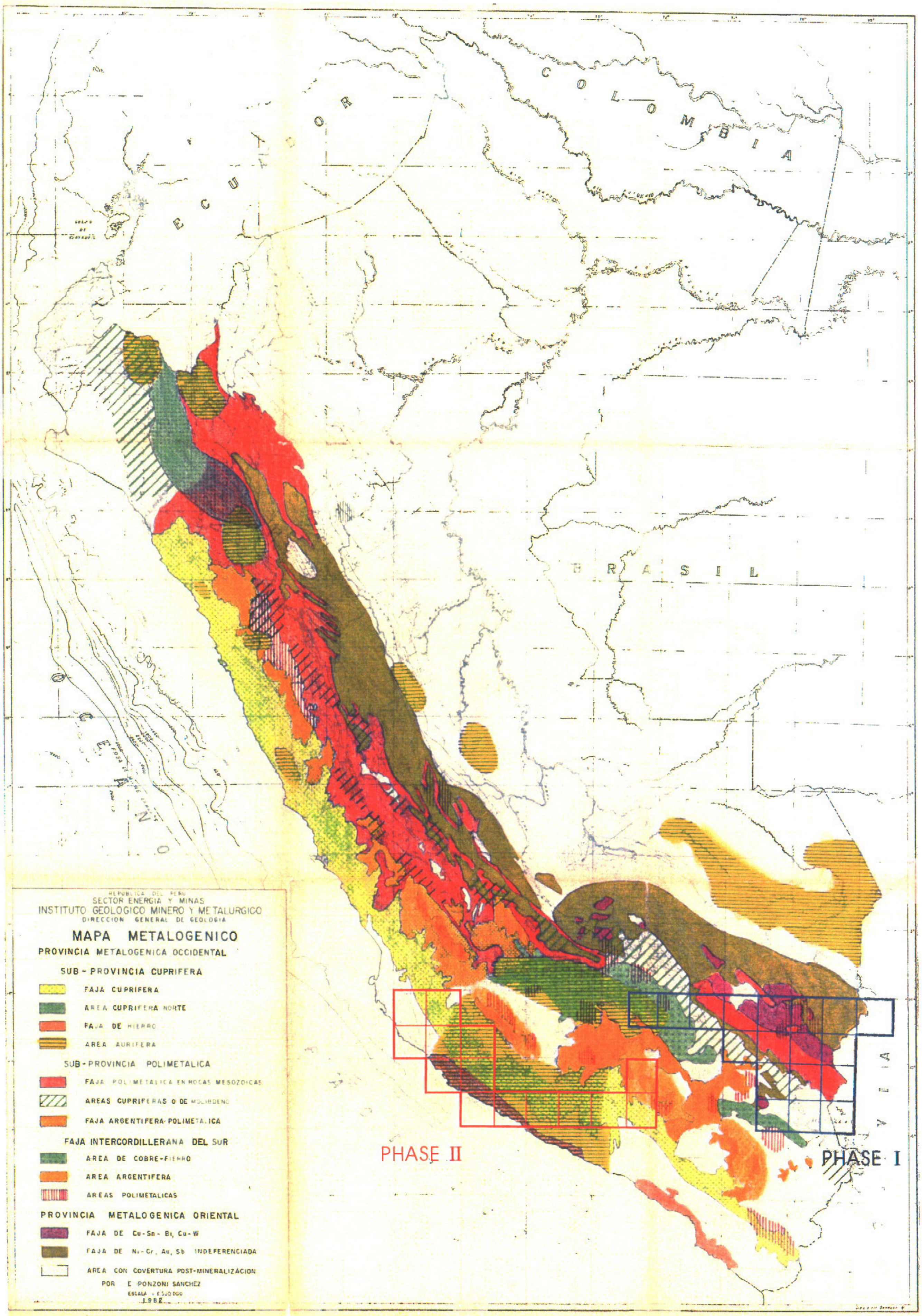
2) Coastal Batholith
The Coastal Batholith is a complex intrusive body which lies concordantly with the Andean trend over 2,400 km from Ecuador in the north to Chile in the south. Within Peru, it is 1,600 km in north-south extension and 60 km wide, stretching over the five Segments, which from the north to southward, are Piura, Trujillo, Lima, Arequipa and Toquepala. The survey area pertains to the Segment of Arequipa
Based upon the Quads. Ica-Cordova, which indicate all the Super-units and measurements of their respective ages, the Arequipa Segment is subdivided into five Super-units which, in chronological order, are Patap, Linga, Pampahuasi, Incahuasi and Tiabaya. Generally, the Linga Super-unit is treated as of the yougest age in the Arequipa Segment; therefore, correlation of intrusion has to be made carefully.
Patap Super-unit (Ki-pt): Composed of gabbroic rocks, whose facies are divided into olivine-pyroxene gabbro, two-pyroxene gabbro, augite-hornblende gabbro, and hornblende gabbro, of which the last two are the principal facies.
Linga Super-unit (Ki-li): Composed mainly of monzonitic rocks. The rock facies are of monzogabbro, monzodiorite, monzonite, quartz monzonite, tonalite, granodiorite, monzogranite and granite. In the area of the Super-unit, copper, iron and molybdenum mineralization is observable. The K-Ar dating indicates 97±3 m.y.
Pampahuasi Super-unit (Ks-pa): Distributed only in the Quad. Cordova; composed mainly of diorite accompanied by tonalite; cut by tonalite of the Tiabaya Super-unit; and, the K-Ar and the U-Pb dating indicate 94 m.y.
Incahuasi Super-unit (Ks-in): Composed mainly of granodiorite to tonalite, accompanied by gabbro-diorite, diorite, monzodiorite, monzogranite, granite, etc. The K-Ar dating indicates 82.5±1.4 m.y., while 90.8±18m.y. and 94.7±11.7 m.y. are obtained by the Rb-Sr whole rock isochron dating.
Tiabaya Super-unit (Ks-ti): Composed mainly of granodiorite accompanied by tonalite, gabbro-diorite. quartz diorite, monzogranite and adamellite. The K-Ar dating indicates 82.5±1.4 m.y.
In the Quad. Nazca, lies a small granite stock intruding into granodiorite of the Tiabaya Super-unit. The stock is made up of reddish leucocratic, medium-grained rocks, occasionally of porphyritic texture, and accompanied by pegmatitic granite and aplitic microgranite. The stock is considered to correspond to the final period of the igneous activity of the Batholith in the Segment.
In the Quads. Orcopampa and Huambo in the extreme east of the survey area, the Coastal

Batholith was not divided into the mentioned five Super-units but only to the western bodies and northeastern bodies. The former is composed mainly of diorite accompanied by tonalite, granodiorite and adamellite, while the latter are made up chiefly of adamellite to granodiorite and white granite to pink granite, correlated with the Tiabaya Super-unit.
The division into the five Super-units is neither made in the Quads. San Juan, Acari and Yauca, but descriptions are given on the Acari Diorite, the Calapampa Tonalite, the San Vicente Tonalite and the Cobrepampa Monzonite.
The Acari Diorite is made up mainly of gray to greenish gray, coarse-grained diorite, which is surrounded by greenish gray, fine-grained diorite. Leucocratic quartz diorite intrudes into these rocks; moreover, magnetite veins and pyroxene dikes accompanied by albitization intrude into them and, finally, quartz veins and carbonate veins are formed. The body has been considered to be concerned in the mineralization of the Acari iron ore deposits. While the INGEMMET maps (1999) assigned the body to the Jurassic, this Report correlates it with the Patap Super-unit in view of the lithologic character.
The Calapampa Tonalite is made up mainly of gray, coarse-grained tonalite, which changes the facies outward into diorite or granodiorite, accompanied by some sulfides. The San Vicente Tonalite is made up of light gray, coarse-grained tonalite accompanied by some sulfides. It has been considered to be concerned in the formation of Los Incas gold vein deposits. In this Report, these intrusives are correlated with the Linga Super-unit.
The Cobrepampa Monzonite is composed mainly of gray to pinkish quartz monzonite which, at its outer peripheries, is replaced by pink adamellite accompanied by adamellite dikes. As most of the vein-type copper deposits at Acari lie around them, the body has been considered to be concerned in the copper mineralization in the zone. The INGEMMET maps (1999) correlate the body with the Linga Super-unit.

(3) Cenozoic intrusive rocks
The Cenozoic intrusive rocks can be classified into granitic rock, small-scale, intrusive rocks originating in the late volcanic activity of the Coastal Batholith at the end of the Cretaceous age and hypabyssal rocks of the upper Cretaceous to Paleogene and early Neogene ages.
As regards the granitic intrusive rocks, no definite index to determine the intrusion time has been indicated. In this Report, the intrusive rocks are included in the mentioned Coastal Batholith.

1) Upper Cretaceous to Paleogene hypabyssal rocks
A dacitic stock lies over 25 km x 4 km along the WNW-ESE fault extending from the central part southeastward in the Quad. Huambo. The stock, called the Ashma Stock, has been considered to derive from the final activity of the Coastal Batholith and causes no hydrothermal alteration to the country rocks. As the dikes intrude into the Arcurquina Formation and are underlain by the Tacaza Group, these are correlated with the upper Cretaceous to Paleogene.

2) Neogene hypabyssal rocks (P-an/ri)
In the extreme north and the central part of the Quad. Nazca, lies a light gray dacite stock, which turns yellowish due to weathering. The stock, intruding into the Tacaza Group and underlain by a formation corresponding to the Alpabamba Formation, is correlated with the lower Miocene.
In the northwestern edge of the Quad. Caraveli, lies a small dacite and andesite stock intruding into the Huaylillas Formation. The stock is correlated with the Neogene.
From the northeast of the Quad. Huambo to the southern end of the Orcopampa, and at the central part of the Orcopampa, lie dacite to rhyolite stocks intruding into the Tacaza Group. The stocks have been considered to be formed by igneous activity deriving from the volcanism



After; Ponzoni, E. (1980)

Fig.14 Metallogenic province of Peru

of the Tacaza Group, which is breccia intrusive activity succeeding the volcanic eruption, accompanied by intensive hydrothermal alteration (silicification) and pyritization. The rocks assume a grayish green color due to chloritization.

2-3 Geologic Structure

The geologic structure in the survey area makes the topographic features conspicuous. Topographically, the area is roughly divided, from the Pacific coast eastward, into the Coastal Cordillera, the Pre-andean Plain and the Cordillera Occidental. Within the Cordillera Occidental, lies volcanic cone belt concordant with the macrostructure.

The Coastal Cordillera is made up of the Precambrian Basal Complex, lower Paleozoic sedimentary and intrusive rocks, and constitutes a horst formed with block fault zones generally striking N50°-60°W. Although the fold structure of the Paleozoic is unclear, presence of a semi-dome structure open toward the Pacific side in the vicinity of Marcona has been reported.

The Pre-andean Plain, excepting the areas covered by the Coastal Cordillera, is the so-called Coastal Plain. The Plain in the survey area is mainly underlain by the Mesozoic rocks, where strike-separation faults in the Andean trend develop.

The Cordillera Occidental is geotectonically divided into the western slope of the Andes and the Altiplano. The western slope of the Andes is a gravity fault zone accompanied by wide-frequency folding and by a coastal batholith intrusion zone, as well. Intrusion structure of the Coastal Batholith is controlled by the past fractures trending NW-SE, E-W and, rarely, NE-SW and deformed by later tectonic movements. The Coastal Batholith has been considered to have caused contact metamorphism to country rocks thereby erasing the original texture but not concerned in formation of folds and faults. The gravity faults were formed again after the intrusion of batholith, to form the horst structure.

In the Quad. Huambo in the eastern most of the survey area, an intensive tectonic zone (compression zone) extends from the topmost part of the western slope of the Andes to the Altiplano. There are zones of recumbent folds and high-angle thrust faults. The recumbent folds generally form pairs with the overturned anticlinal axes. Most of the fold axes are short, occasionally aligned in echelon. The trend is N45°W, continuously from the north, but changes to N60°E at the Colca River. It bends again at the southeastern end of the survey area to return to the Andean trend. The deflection resembles the strike displacement structure called the 'Abancay Deflection' in the north of the survey area.

The Altiplano in the Cordillera Occidental, situated in the Quad. Orcopampa in the east of the survey area, is made up chiefly of Tertiary and Quaternary volcanic rocks and continental sediments. Recent volcanic zones are classified as volcanic cone belt. The Altiplano is a block fault zone situated in the compression stress field. The Tertiary rocks are of weak fold structure, generally exhibiting the anticlinorium structure. NW-SE trending faults generally have right-lateral separation, which has been read from the slickensides. Quaternary volcanoes, originating in the reactivation of these faults in the tension field, are linearly aligned.

2-4 Ore Deposits

Ponzoni E.(1980) indicates that the metallogenic provinces in Peru are roughly divided into the Western and the Eastern Metallogenic Provinces, the former being subdivided into three sub-provinces while the latter into two. According to the division, the survey area is situated in the cupreous and polymetallic sub-provinces in the Western Metallogenic Province. The cupreous sub-province is further subdivided into copper ore zone, iron ore zone and gold ore zone (Fig.14).

The INGEMMET(1995) has established four metallogenic zones, which are, from the Pacific

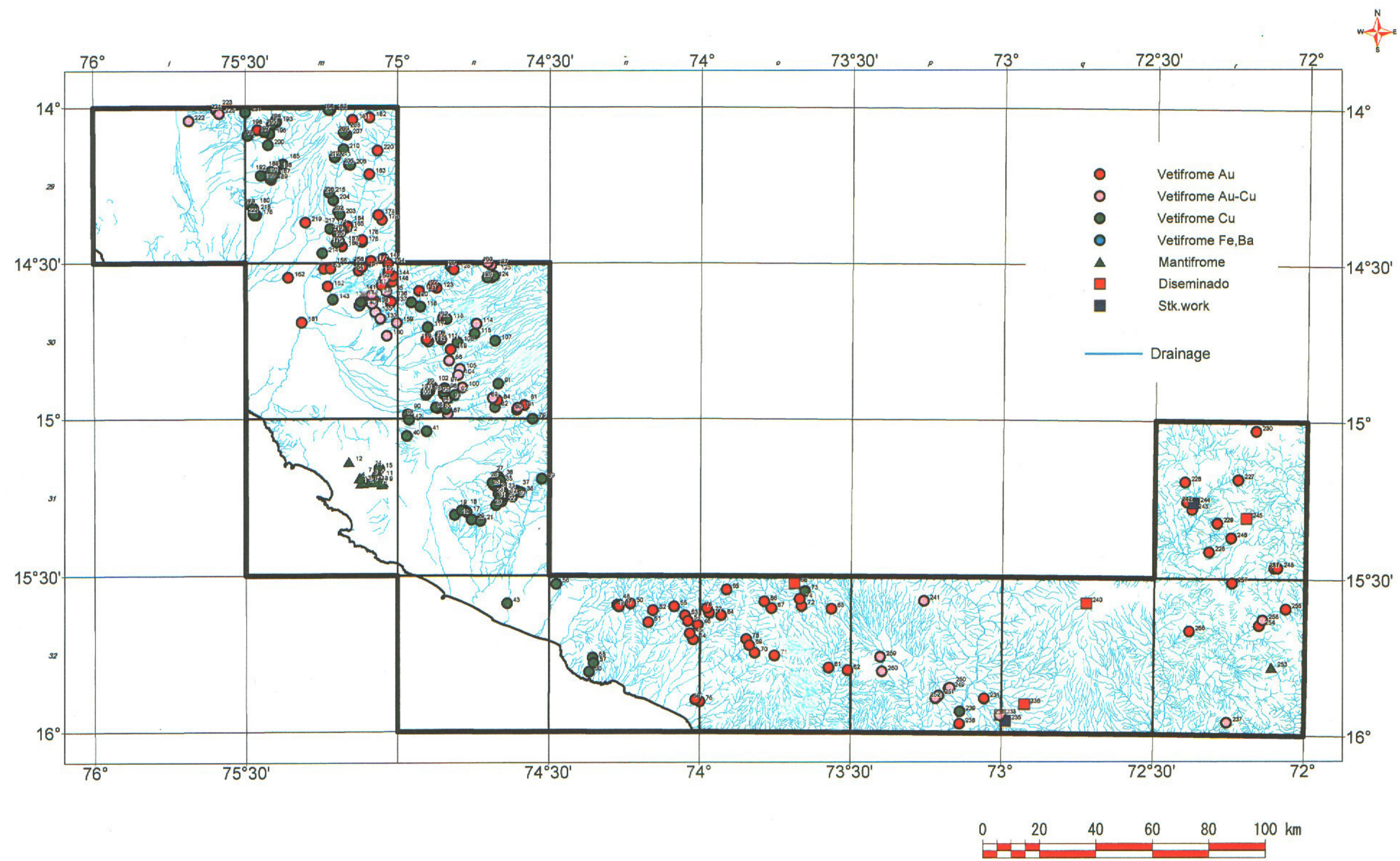


Fig.15 Location map of ore deposits and indications

Table 6 List of ore deposits and indications

YACIMIENTOS Y OCURRENCIAS METALICAS

N°	NOMBRE	DPTO	HOJA	COORDENADAS UTM NORTE	COORDENADAS UTM ESTE	TIPO DE YACIMIENTO	ELEM.	MINERAL METALICO PRINCIPAL	MINERAL METALICO ACCESORIO	MINERAL GANGA	ROCA CAJA	FORMACION GEOLOGICA	ESTADO
1	Marcona Mina 1	Ica	31-m	8,318,933	487,008	Mantiforme	Fe	Mag, Hem, Lim, Mrt	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
2	Marcona Mina 2	Ica	31-m	8,318,938	487,721	Mantiforme	Fe	Mag, Hem, Mrt, Mrt	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
3	Marcona Mina 4	Ica	31-m	8,319,574	488,692	Mantiforme	Fe	Mag, Hem, Mrt, Lim	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
4	Marcona Mina 5	Ica	31-m	8,320,791	486,490	Mantiforme	Fe	Mag, Hem, Lim	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
5	Marcona Mina 6	Ica	31-m	8,320,102	491,594	Mantiforme	Fe	Mag, Mrt, Hem, Lim	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
6	Marcona Mina 7	Ica	31-m	8,319,373	490,188	Mantiforme	Fe	Mag, Hem, Mrt Lim	Oxcu	Gyp, Act, Q	Hornfels, Cuarcitas	Fm. Marcona (E-ms)	Activo
7	Marcona Mina 8	Ica	31-m	8,320,599	487,336	Mantiforme	Fe	Mag, Hem, Mrt, Lim	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
8	Marcona Mina 9 y 10	Ica	31-m	8,320,038	490,842	Mantiforme	Fe	Mag, Hem, Mrt, Lim	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
9	Marcona Mina 11	Ica	31-m	8,319,200	494,808	Mantiforme	Fe	Mag, Hem, Mrt, Lim	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
10	Marcona Mina 12	Ica	31-m	8,318,557	494,418	Mantiforme	Fe	Mag, Hem, Mrt, Lim	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
11	Marcona Mina 14	Ica	31-m	8,319,546	493,596	Mantiforme	Fe,Cu	Cp, Po, Mag	Oxcu	Py,Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Inactivo
12	Marcona Mina 15	Ica	31-m	8,326,432	482,710	Mantiforme	Fe	Mag, Hem, Lim, Mrt	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
13	Marcona Mina 16	Ica	31-m	8,319,363	491,818	Mantiforme	Fe	Mag, Hem, Lim	Oxcu	Gyp, Act, Q	Hornfels	Fm. Marcona (E-ms)	Activo
14	A-45	Ica	31-m	8,323,144	492,497	Mantiforme	Fe,Cu	Hem,Cris,Mag,Br	Espe	Q	Andesita porfirítica	Fm. Guaneros (Js-vs)	Inactivo
15	Veta Pista # 8	Ica	31-m	8,323,978	493,366	Vetiforme	Fe,Cu	Hem,Cris,Mag,Br	Espe	Q,Cl	Andesita porfirítica	Fm. Guaneros (Js-vs)	Inactivo
16	Mirador del Condor	Arequipa	31-n	8,307,561	520,137	Vetiforme	Fe	Mag, Hem	Mrt		Granodiorita	Patap (Ki-di/gb)	Inactivo
17	Urbina	Arequipa	31-n	8,308,540	524,340	Vetiforme	Fe	Mag, Hem	Mrt	Act,Apt	Diorita	Patap (Ki-di/gb)	Activo
18	Central	Arequipa	31-n	8,309,326	523,273	Vetiforme	Fe	Mag, Hem	Mrt	Q,Apt	Diorita	Patap (Ki-di/gb)	Activo
19	María 3	Arequipa	31-n	8,309,092	522,617	Vetiforme	Fe	Mag, Hem	Mrt	Q,Apt	Diorita	Patap (Ki-di/gb)	Activo
20	La Mancha	Arequipa	31-n	8,305,888	526,107	Vetiforme	Fe	Hem,Mag		Q	Granodiorita	Patap (Ki-di/gb)	Inactivo
21	Veta N°5	Arequipa	31-n	8,305,477	529,287	Vetiforme	Fe	Mag, Hem		Q	Granodiorita	Patap (Ki-di/gb)	Inactivo
22	Purísima	Arequipa	31-n	8,312,200	536,738	Vetiforme	Cu	Oxcu,Cc,Cup,Cris,Az	Oxfe	Q	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
23	Magdalena	Arequipa	31-n	8,315,174	535,549	Vetiforme	Cu	Oxcu,Cup,Cc,Cp,Cris	Oxfe	Q	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
24	Condor Grande	Arequipa	31-n	8,316,995	535,586	Vetiforme	Cu	Cup,Oxcu,Cp,Cris,Atac	Az, Oxfe	Q	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
25	Cobreña	Arequipa	31-n	8,317,945	534,130	Vetiforme	Cu	Cup,Oxcu,Cp,Atac	Cris, Az, Oxfe	Q	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
26	Palca	Arequipa	31-n	8,318,954	533,538	Vetiforme	Cu	Cup,Oxcu,Cp,Cv,Az	Atac,Cris	Q	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
27	Argentina	Arequipa	31-n	8,321,084	535,558	Vetiforme	Cu	Atac,Cup,Cris	Espe,Lim,Py	Ca,Q,Tur,Apt	Adamelita	Linga(Ki-mzgr/gr)	Inactivo
28	Génova	Arequipa	31-n	8,310,980	534,763	Vetiforme	Cu	Cp,Oxcu,Cup,Cris,Cv	Oxfe	Q	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
29	Santa Rosa	Arequipa	31-n	8,314,139	538,351	Vetiforme	Cu	Ml,Oxcu,Cris	Espe	Q,Ca	Granodiorita	Linga(Ki-mzgr/gr)	Inactivo
30	Huarato	Arequipa	31-n	8,314,017	540,650	Vetiforme	Cu	Cp,Oxcu,Cup,Ml	Hem,Mag,Espe	Act, Q	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
31	Rosa María	Arequipa	31-n	8,313,442	536,245	Vetiforme	Cu	Ml,Cup,Cc,Cv,Cp	Py	Q,Gyp	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
32	La Curva	Arequipa	31-n	8,314,869	537,628	Vetiforme	Cu	Ml,Cup,Cc,Cv	Py	Q,Gyp	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
33	San José	Arequipa	31-n	8,315,832	537,038	Vetiforme	Cu	Oxcu,Cup,Ml,Cv	Py	Q,Gyp	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
34	Perricholi	Arequipa	31-n	8,319,591	535,620	Vetiforme	Cu	Oxcu,Cup,Ml,Cv	Py	Q,Gyp	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
35	La Chilena	Arequipa	31-n	8,319,105	536,098	Vetiforme	Cu	Oxcu,Cup,Ml,Atac,Cv	Py,Espe,Lim	Q,Ca,Tur,Act	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
36	La Ñusta	Arequipa	31-n	8,319,639	536,274	Vetiforme	Cu	Cup,Ml,Atac,Cv	Py,Espe,Lim	Ca,Tur,Q,Act	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
37	Huarato Viejo	Arequipa	31-n	8,316,147	542,055	Vetiforme	Cu	Cup,Ml,Atac,Cv	Py,Espe,Lim	Ca,Tur,Q,Act	Monzonita cuarcífera	Linga(Ki-mzgr/gr)	Inactivo
38	Brasil	Arequipa	31-n	8,315,635	543,507	Vetiforme	Cu	Oxcu,Cup,Ml,Atac	Py,Espe,Lim	Ca,Tur,Q,Act	Tonalita	Linga(Ki-mzgr/gr)	Inactivo
39	Mashaynioc	Arequipa	31-n	8,320,310	550,987	Vetiforme	Cu	Cp	Mag,Espe,Py,Po	Act,Ca,Q,Tur	Esquisto	Complejo Santa Rita (Kti-csr)	Activo
40	Ratonera	Ica	31-n	8,335,554	503,178	Vetiforme	Cu	Oxcu,Ml,Cris,Cp		Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactivo
41	Copara	Ica	31-n	8,337,205	510,156	Vetiforme	Cu,Au	Oxcu,Cup,Cp,Ml,Az	Cris	Q	Areniscas, Grauwacas	Gpo. Casma (Kis-vs)	Inactivo
42	Cerro Negro	Ica	31-n	8,341,327	503,978	Vetiforme	Cu,Au	Cup,Oxcu,Ml,Cris	Hem,Lim	Q	Gabrodiorita	Patap (Ki-di/gb)	Inactivo
43	Monasí	Arequipa	32-n	8,276,515	538,765	Vetiforme	Cu	Oxcu	Hem,Lim	Q,Jar	Andesita	Bella Unión (Ki-an/da)	Inactivo
44	Víbora	Arequipa	32-ñ	8,263,609	604,694	Vetiforme	Au	Cp,Au	Oxfe,Py,Lim	Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactivo

Table 6 List of ore deposits and indications

N°	NOMBRE	DPTO	HOJA	COORDENADAS UTM NORTE	COORDENADAS UTM ESTE	TIPO DE YACIMIENTO	ELEM.	MINERAL METALICO PRINCIPAL	MINERAL METALICO ACCESORIO	MINERAL GANGA	ROCA CAJA	FORMACION GEOLOGICA	ESTADO
45	Reyes	Arequipa	32-ñ	8,265,692	603,554	Vetiforme	Au	Au,Cp	Oxfe,Py,Lim	Q	Andesita de anfíboles	Bella Unión (Ki-an/da)	Inactivo
46	Española	Arequipa	32-o	8,268,810	606,417	Vetiforme	Au	Au,Cris	Py,Oxfe	Q	Diorita	Linga(Ki-mzgr/gr)	Inactivo
47	Ana María I	Arequipa	32-ñ	8,275,821	578,558	Vetiforme	Au	Au,Cris	Oxfe	Q	Diorita	Linga(Ki-mzgr/gr)	Activo
48	Orión	Arequipa	32-ñ	8,275,863	577,782	Vetiforme	Au	Cp,Au,Cris	Py,Oxfe	Q	Roca volcanica alterada	Bella Unión (Ki-an/da)	Activo
49	Francia	Arequipa	32-ñ	8,275,297	578,370	Vetiforme	Au	Cp,Au	Py,Oxfe	Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactivo
50	Cruz	Arequipa	32-ñ	8,276,341	582,518	Vetiforme	Au	Cp,Cris,Au	Py,Oxfe,Lim	Q	Dacita	Linga(Ki-mzgr/gr)	Inactivo
51	La María	Arequipa	32-ñ	8,269,703	588,840	Vetiforme	Au	Pyau,Cp,Oxcu	Hem	Q	Toba alterada a cloritas	Fm. Guaneros (Js-vs)	Activo
52	San Andrés	Arequipa	32-ñ	8,273,914	590,485	Vetif/Mantif	Au	Cp,Pyau	Oxfe,Lim,Ars	Q,Jar	Metavolcánico	Fm. Guaneros (Js-vs)	Activo
53	Capitana	Arequipa	32-ñ	8,272,050	601,858	Vetiforme	Au	Cp,Sph,Ga,Cup,Ml,Cris	Ars,Py,Mar,Hem	Q,Ca	Roca volcanica alterada	Tiabaya (Ks-mzgr/gdi)	Activo
54	Chino	Arequipa	32-ñ	8,270,126	602,824	Vetiforme	Au	Cp, Pyau,Cris	Py<Hem,Lim,Oxm	Ca,Q	Tonalita	Tiabaya (Ks-mzgr/gdi)	Activo
55	San Juan	Arequipa	32-ñ	8,275,265	597,980	Vetiforme	Au	Pyau,Au	Hem,Lim	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactivo
56	Chiachilla	Arequipa	32-ñ	8,283,347	556,117	Vetiforme	Cu,Au	Cp,Cris,Ml	Oxfe	Q,Jar,Ca,Gyp	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactivo
57	Castillo	Arequipa	32-ñ	8,255,372	569,420	Vetiforme	Fe,Cu,Au	Ml,Cris	Oxfe,Mag	Q	Cuarzo monzodiorita	Linga(Ki-mzgr/gr)	Inactivo
58	Tarillo	Arequipa	32-ñ	8,257,247	569,093	Vetiforme	Cu	Ml,Cris	Oxfe,Hem,Mag	Q	Cuarzo monzodiorita	Linga(Ki-mzgr/gr)	Inactivo
59	San Francisco	Arequipa	32-ñ	8,242,360	605,488	Vetiforme	Au	Pyau,Au,Cris,Cp	Lim	Q,Gyp,Ca	Andesita basáltica	Fm. Chocolate (Ji-vs)	Activo
60	Atiquipa	Arequipa	32-ñ	8,252,228	567,771	Vetiforme	Cu,Fe	Oxcu,Cris	Hem,Gth	Q,Ca	Monzodiorita	Linga(Ki-mzgr/gr)	Inactivo
61	Bonanza	Arequipa	32-o	8,253,532	652,719	Vetiforme	Au	Cp,Cris	Py,Oxfe,Lim	Q,Gyp,Ca,Arc	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactivo
62	Calpa	Arequipa	32-o	8,252,589	659,480	Vetiforme	Au	Cp,Pyau		Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Activo
63	Lucchune	Arequipa	32-o	8,274,364	653,725	Vetiforme	Au	Au	Lim,Hem,Oxmn	Q	Diorita de anfíboles	Patap (Ki-di/gb)	Inactivo
64	Tambojasa	Arequipa	32-o	8,272,130	614,621	Vetiforme	Au		Hem,Oxmn	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactivo
65	Huanuhuanu	Arequipa	32-o	8,281,260	616,558	Vetiforme	Au	Cp	Lim,Hem,Oxfe	Q,Gyp,Or	Granodiorita-Monzogranito	Tiabaya (Ks-mzgr/gdi)	Inactivo
66	Molles	Arequipa	32-o	8,276,975	630,019	Vetiforme	Au		Hem	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactivo
67	Las Bravas	Arequipa	32-o	8,274,596	632,542	Vetiforme	Au	Pyau	Oxfe	Q	Tonalita	Tiabaya (Ks-mzgr/gdi)	Inactivo
68	Marcahui	Arequipa	32-o	8,283,366	640,734	Diseminado	Cu,Mo	Cp,Carbcu	Hem,Oxmn	Q	Granodiorita	Patap (Ki-di/gb)	Inactivo
69	Convento	Arequipa	32-o	8,261,496	624,728	Vetiforme	Au	Au	Lim,Hem	Q, Ser	Esquisto de cuarzo-micas	Comp. Basal de la Costa (Pe-B)	Inactivo
70	San silvestre	Arequipa	32-o	8,258,915	626,594	Vetiforme	Au	Cp	Py	Q	Monzonita	Linga(Ki-mzgr/gr)	Inactivo
71	Torrecillas	Arequipa	32-o	8,257,824	633,614	Vetiforme	Au			Ser	Volcanicos alterados (Ser-Q)	Bella Unión (Ki-an/da)	Activo
72	San José I	Arequipa	32-o	8,275,385	643,178	Vetiforme	Au	Pyau	Hem	Q, Ser	Gneis? de Plag-Q-anfiboles-Bio	Patap (Ki-di/gb)	Inactivo
73	Huayllacha	Arequipa	32-o	8,280,625	644,457	Vetiforme	Au,Ag	Pyau,Cp,Ttr,Cv,Cc	Lim,Hem	Q	Granodiorita-Tonalita	Patap (Ki-di/gb)	Inactivo
74	Ranraminas	Arequipa	32-o	8,277,803	642,525	Vetiforme	Au	Au	Hem,Lim,	Q,Ser	Granodiorita/Gabrodiorita	Patap (Ki-di/gb)	Inactivo
75	Chuqui	Arequipa	32-o	8,241,692	607,010	Vetiforme	Au	Pyau,Au,Cp	Lim	Q,Gyp,Ca,Or	Granodiorita/Monzogranito	Linga(Ki-mzgr/gr)	Inactivo
76	Puruja	Arequipa	32-o	8,263,715	623,624	Vetiforme	Au		Py,Oxfe	Q	Tonalita	Tiabaya (Ks-mzgr/gdi)	Inactivo
77	C° Llauqui	Arequipa	32-o	8,273,050	610,349	Vetiforme	Au	Pyau,Au]	Hem,Oxmn	Q	Metatonalita	Tiabaya (Ks-mzgr/gdi)	Inactivo
78	Huambo	Arequipa	32-o	8,274,750	609,660	Vetiforme	Au	Au	Hem.Oxfe	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactivo
79	Sta Bertita de Humay	Ayacucho	31-n	8,341,543	547,722	Filoniano	Au	Au,Carcu,Cris	Py	Q,Cln	Tonalita/Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
80	Mayta Capac	Ayacucho	30-n	8,344,735	542,175	Filoniano	Au,Cu	Pyau,Cp,Oxcu	Oxfe	Q	Tonalita/Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
81	Kjara Kjara	Ayacucho	30-n	8,346,464	544,850	Filoniano	Au	Au	Py,Lim,Hem	Q	Tonalita/Monzonita	Tiabaya (Ks-mzgr/gdi)	Activa
82	Los Incas	Ica	30-n	8,345,666	534,361	Filoniano	Au	Au,Cp,Ml,Cris	Py,Hem,Espe	Q,Ca	Cuarcitas	Tiabaya (Ks-mzgr/gdi)	Activa
83	Virgen María	Ayacucho	30-n	8,348,991	533,610	Filoniano	Au,Cu	Au,Cris	Py	Q	Pizarras	Fm. Guaneros (Js-vs)	Inactiva
84	Pachacutec	Ayacucho	30-n	8,348,166	535,210	Filoniano	Au		Lim	Q	Andesita	Bella Unión (Ki-an/da)	Inactiva
85	Santa Luisa	Ica	30-n	8,345,033	516,956	Filoniano	Cu	Oxcu		Q	Granodiorita	Linga(Ki-mzgr/gr)	Inactiva
86	Sol de Oro	Ica	30-n	8,362,266	518,122	Filoniano	Au,Cu	Ml	Py,Hem	Q	Andesitas	Fm. Guaneros/Tiabaya	Inactiva
87	Sol de Oro 1	Ica	30-n	8,343,384	517,539	Filoniano	Au,Cu	Cp,Ml,Oxcu		Q	Andesitas	Fm. Guaneros/Tiabaya	Inactiva
88	El Progreso - cantera.	Ica	30-n	8,345,444	514,062	Filoniano	Cu,Au	OxCu	Lim	Q,Cln	Andesitas/Granodioritas	Gp. Casma/Tiabaya	Inactiva
89	Chauchilla	Ica	30-n	8,342,932	503,552	Filoniano	Cu	Ml,Cris,Carcu	Oxfe	Q	Andesitas/Granodioritas	Gp. Casma/Tiabaya	Inactiva
90	Clavelinas	Ica	30-n	8,343,200	503,502	Filoniano	Cu,Au	Ml,Cris	Hem	Q,Ca	Granodioritas	Gp. Casma/Tiabaya	Inactiva
91	Florencia	Ica	30-n	8,353,971	535,520	Filoniano	Cu	Ml,Cris	Hem	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva

Table 6 List of ore deposits and indications

N°	NOMBRE	DPTO	HOJA	COORDENADAS UTM NORTE	COORDENADAS UTM ESTE	TIPO DE YACIMIENTO	ELEM.	MINERAL METALICO PRINCIPAL	MINERAL METALICO ACCESORIO	MINERAL GANGA	ROCA CAJA	FORMACION GEOLOGICA	ESTADO
92	Caudalosa	Ica	30-n	8,350,083	520,186	Filoniano	Cu	Ml,Cris	Lim,Espe	Q,Ca	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
93	Mina Tunga	Ica	30-n	8,348,680	517,600	Filoniano	Cu,Au	Ml,Ga,Cris	Espe,Lim	Q, Ca	Granodiorita-Tonalita/Cuarcita	Tiabaya (Ks-mzgr/gdi)	Inactiva
94	Copara N°1	Ica	30-n	8,345,713	513,463	Filoniano	Cu	Cp,Ml	Hem	Q	Andesitas	Bella Unión (Ki-an/da)	Inactiva
95	Chauchilla Alta	Ica	30-n	8,350,955	516,198	Filoniano	Cu,Au	Ml,Cris	Oxfe	Q	Cuarcita/Granodiorita	Gpo. Yura/Tiabaya	Inactiva
96	Santa Inés de Juanillo	Ica	30-n	8,350,308	516,271	Filoniano	Cu,Au	Cp,Ml,Cris	Oxfe	Q,Ca	Granodiorita-Tonalita/Cuarcita	Tiabaya/Gpo. Yura	Inactiva
97	Raúl Isaías N° 2 denuncio	Ica	30-n	8,352,439	516,449	Filoniano	Cu,Au	Ml	Py	Cl,Epi	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
98	San Felipe	Ica	30-n	8,351,390	511,182	Filoniano	Cu,Au	Bo,Cp	Lim	Q,Ca	Andesitas/Granodioritas	Gp. Casma/Incahuasi	Inactiva
99	Santa Polonia	Ica	30-n	8,352,084	511,056	Filoniano	Cu,Au	Cp,Ml	Oxfe	Q	Diorita	Bella Unión (Ki-an/da)	Inactiva
100	Juanillo	Ica	30-n	8,352,731	522,826	Filoniano	Au,Cu	Au	Py,Espe	Q,Ca,Act,Tre	Cuarcitas	Fm. Guaneros Inf.	Inactiva
101	Taruga	Ica	30-n	8,350,142	509,927	Filoniano	Cu,Au	Ml,Cris	Espe.	Ml,Cris	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
102	Falda Grande -Prospecto.	Ica	30-n	8,353,039	511,951	Filoniano	Cu,Au	Au	Hem, Lim	Q	Diorita	Bella Unión (Ki-an/da)	Inactiva
103	Santa Berta N°1-denuncio.	Ica	30-n	8,351,014	510,045	Filoniano	Cu,Au	Ml	Hem, Lim	Q	Diorita	Bella Unión (Ki-an/da)	Inactiva
104	Paulita	Ica	30-n	8,357,130	521,269	Filoniano	Au,Cu	Cp,Bo,Oxcu,Sulfcu	Py,Hem	Q	Andesitas	Fm. Guaneros (Js-vs)	Activa
105	Mina de Oro	Ica	30-n	8,359,270	521,873	Filoniano	Au,Cu	Au	Py,Hem	Q	Andesitas	Guaneros/Bella Unión	Inactiva
106	San Lorenzo N°22	Ica	30-n	8,362,266	518,122	Filoniano	Au,Cu	Au,Ml,Cris,Oxcu	Py,Hem	Q	Andesitas	Fm. Guaneros (Js-vs)	Inactiva
107	Mollepampa	Ica	30-n	8,369,225	534,420	Filoniano	Cu,Au	Cp,Ml,Oxcu	Hem	Q, Ca	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
108	Santa Catalina	Ica	30-n	8,368,734	521,067	Filoniano	Cu,Au	Cp	Hem	Q	Andesita/Granodiorita	Fm. Guaneros/Tiabaya	Inactiva
109	Santa Rosa -Prospecto.	Ica	30-n	8,370,798	515,066	Filoniano	Cu,Au	Au	Lim	Q	Andesita/Piroclastico	Fm. Guaneros Sup./Gpo. Nasca	Inactiva
110	Brillante - Mina	Ica	30-n	8,350,955	516,198	Filoniano	Au,Au	Au	Py,Lim	Q	Andesitas	Fm. Guaneros (Js-vs)	Inactiva
111	Rey de Oro	Ica	30-n	8,369,730	515,347	Filoniano	Au,Cu	Oxcu	Py	Q	Andesitas	Fm. Guaneros (Js-vs)	Inactiva
112	Alto Pongo	Ica	30-n	8,369,008	510,796	Filoniano	Au,Cu	Oxcu	Py	Q	Cuarcita/Andesitas	Gpo. Yura/Fm. Guaneros	Inactiva
113	La Española - Mina	Ica	30-n	8,369,763	510,150	Filoniano	Au	Au	Lim	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
114	Trapiche	Ica	30-n	8,375,234	527,798	Filoniano	Au,Cu	Ml,Cris	Py,Hem	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
115	Pirca Grande	Ica	30-n	8,371,730	527,163	Filoniano	Cu,Au	Ml,Cris	Oxfe	Q	Granodiorita	Tiabaya/Gpo. Nasca	Inactiva
116	Oropalla N°3	Ica	30-n	8,376,889	517,325	Filoniano	Cu,Au	Ml,Cris	Py	Q	Granito	Tiabaya (Ks-mzgr/gdi)	Activa
117	El Condor	Ica	30-n	8,374,027	510,569	Filoniano	Cu,Au	Cp	Oxfe	Q, Ca	Granodiorita/Cuarcita	Tiabaya/Fm. Guaneros	Inactiva
118	Tunal	Ica	30-n	8,381,287	507,961	Filoniano	Au	Ml,Cris	Hem	Q	Granodiorita/Cuarcita	Tiabaya/Gpo. Yura	Inactiva
119	Orpendia - Mina	Ica	30-n	8,366,200	518,615	Filoniano	Au	Au	Lim	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
120	Hualpoca	Ica	30-n	8,382,854	504,814	Filoniano	Cu,Au	Ml,Oxcu	Oxfe	Q	Granodiorita-Tonalita	Tiabaya (Ks-mzgr/gdi)	Inactiva
121	Fortuna 85 - Unidad.	Ica	30-n	8,386,936	507,517	Filoniano	Au	Au	Py,Lim	Q	Granodiorita-Tonalita	Tiabaya (Ks-mzgr/gdi)	Inactiva
122	Agua Perdida	Ica	30-n	8,388,668	512,311	Filoniano	Au	Oxcu	Oxfe	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
123	Aidita	Ica	30-n	8,387,885	513,758	Filoniano	Au	Oxcu	Py	Q,Ca,Cln	Cuarcitas	Gpo. Yura/Bella Unión	Inactiva
124	Túpac Amaru	Ica	30-n	8,391,610	533,352	Filoniano	Cu,Au	Cp,Oxcu		Q,Tur	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
125	Yanajaja	Ica	30-n	8,392,230	534,154	Filoniano	Cu	Cp	Oxfe,Espe	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
126	El Diluvio	Ayacucho	30-n	8,391,649	531,684	Filoniano	Cu	Cp,Ga,Sph	Py	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
127	El Dorado Prospecto.	Ayacucho	30-n	8,396,033	533,157	Filoniano	Au,Cu	Au	Lim	Q, Ca	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
128	Dame la Mano - Mina	Ica	30-n	8,394,555	519,769	Filoniano	Au	Au	Hem, Lim	Q	Pizarra silicificada	Gpo.Yura (JsKi-mc)	Inactiva
129	La Grieta - Mina	Ica	30-n	8,395,564	518,775	Filoniano	Cu	Cu	Py,Lim	Q	Cuarcitas	Gpo. Yura/Tiabaya	Inactiva
130	Cerca de Otoca	Ica	30-n	8,396,920	531,800	Filoniano	Au,Cu	Au	OxFe	Q,Ca	Dacita	Dacita(P-an/ri)	Inactiva
131	Huaranguillo Alto	Ica	30-n	8,345,513	542,513	Filoniano	Au,Cu		Py,Oxfe	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
132	Condor 1	Ica	30-n	8,377,444	516,006	Filoniano	Au,Cu		Py,Oxfe	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
133	El Frayle	Ica	30-m	8,377,064	493,770	Filoniano	Au,Cu	Cp,Ml	Py	Q,Ca,Cln	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
134	Santa Rica	Ica	30-m	8,384,019	491,383	Filoniano	Au	Oxcu	Hem,Gth	Q	Andesitas	Bella Unión (Ki-an/da)	Inactiva
135	El Ingenio N°4 - denuncio.	Ica	30-m	8,379,455	492,045	Filoniano	Au,Cu	Au,Ml,Cris	Lim,Espe	Q	Andesitas	Bella Unión (Ki-an/da)	Inactiva
136	Ornilla N°1- Mina	Ica	30-m	8,383,062	497,528	Filoniano	Au	Au	Espe.	Q	Pizarras	Fm. Guaneros (Js-vs)	Inactiva
137	Ornilla N°2	Ica	30-m	8,382,794	497,388	Filoniano	Au		Oxfe	Q	Pizarras	Fm. Guaneros/Bella Unión	Inactiva
138	Tentadora	Ica	30-m	8,382,452	490,785	Filoniano	Au,Cu	Oxcu	Hem	Q,Ca	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva

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N°	NOMBRE	DPTO	HOJA	COORDENADAS UTM NORTE	COORDENADAS UTM ESTE	TIPO DE YACIMIENTO	ELEM.	MINERAL METALICO PRINCIPAL	MINERAL METALICO ACCESORIO	MINERAL GANGA	ROCA CAJA	FORMACION GEOLOGICA	ESTADO
139	Estrella Unida - Mina	Ica	30-m	8,382,922	486,890	Filoniano	Cu,Au	Au	Hem	Q	Andesitas	Bella Unión (Ki-an/da)	Inactiva
140	Estrella Unida - Mina	Ica	30-m	8,381,704	486,413	Filoniano	Ba	Ba		Q	Cuarcitas	Fm. Pariatambo (Kis-m)	Inactiva
141	Centauro	Ica	30-m	8,385,337	490,536	Filoniano	Au,Cu	Cp	Py,Hem	Q,Ca,Cln	Andesita porfirítica	Bella Unión (Ki-an/da)	Activa
142	Calera - Mina	Ica	30-m	8,383,348	488,101	Filoniano	Cu	Cu	Lim	Q	Calizas	Fm. Pariatambo (Kis-m)	Inactiva
143	Piedra Gorda	Ica	30-m	8,383,860	477,015	Filoniano	Cu	Ml.	Lim	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
144	Luz del Sol	Ayacucho	30-m	8,392,264	498,223	Filoniano	Au	Ml,Cris	Oxfe	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
145	Luz del Sol 1	Ica	30-m	8,386,769	496,023	Filoniano	Au,Cu	Ml,Cris,Oxcu		Q	Andesitas	Bella Unión (Ki-an/da)	Inactiva
146	Apacheta	Ica	30-m	8,390,240	498,025	Filoniano	Au	Oxcu	Hem	Q	Granodiorita-Tonalita	Tiabaya (Ks-mzgr/gdi)	Inactiva
147	Esperanza	Ica	30-m	8,388,917	494,172	Filoniano	Au	Ml,Cris	Oxfe	Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactiva
148	Yapana	Ayacucho	30-m	8,392,264	498,223	Filoniano	Au	Oxcu	Py	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
149	Santa María	Ica	29-m	8,398,571	494,845	Filoniano	Au	Oxcu	Py,Hem	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
150	Cerca de Belaunde	Ayacucho	30-m	8,391,200	495,219	Filoniano	Au,Cu	Cp,Ml,Cris,Oxcu	Oxfe	Q, Ca	Pizarras alteradas	Gpo.Yura (JsKi-mc)	Inactiva
151	Yuriviscas	Ica	30-m	8,394,197	486,201	Filoniano	Au	Ml,Cris,Oxcu		Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactiva
152	Estrella de Oro - Mina	Ica	30-m	8,388,584	475,163	Filoniano	Au	Au	Py	Q	Andesitas	Bella Unión (Ki-an/da)	Inactiva
153	San Martin de Otongo	Ica	30-m	8,394,889	473,843	Filoniano	Au	Oxcu	Py,Oxfe	Q	Andesitas	Bella Unión (Ki-an/da)	Inactiva
154	Yuri	Ayacucho	30-m	8,396,611	496,551	Filoniano	Au	Cp,Bo,Cc,Ml,Cris	Py,Hem	Q, Ca	Cuarcitas	Gpo.Yura (JsKi-mc)	Activa
155	Orion - Mina	Ayacucho	29-m	8,393,904	496,712	Filoniano	Au	Au	Hem, Lim	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
156	Cachilloc - Mina	Ica	30-m	8,397,044	486,287	Filoniano	Cu,Au	Au	Hem, Lim	Q	Cuarcitas/Pizarras	Gpo.Yura (JsKi-mc)	Inactiva
157	Mina Antigua	Ica	30-m	8,395,522	487,390	Filoniano	Au	Au	Lim	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
158	El Tunal - Mina	Ica	30-m	8,394,936	476,132	Filoniano	Au	Au	Hem, Lim	Q	Lutitas margosas	Fm. Pariatambo (Kis-m)	Inactiva
159	Cruz de Chapi	Ica	30-m	8,375,677	499,630	Filoniano	Au,Cu	Ml,Cris		Q,Cln	Granodiorita-Tonalita	Tiabaya (Ks-mzgr/gdi)	Inactiva
160	Los Colorados	Ica	30-m	8,371,073	496,067	Filoniano	Au,Cu	Ml,Cris	Oxfe,Espe	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
161	San Francisco Javier - Mina	Ica	30-m	8,375,849	465,949	Filoniano	Au	Au	Lim,Hem		Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
162	Estrella de Oro - Mina	Ica	30-m	8,391,734	461,168	Filoniano	Au	Au					Inactiva
163	Mina Coquimbana	Ica	29-m	8,428,573	489,861	Filoniano	Au	Ga	Py	Q,Cln	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
164	Irma Nelida	Ica	29-m	8,410,076	482,232	Filoniano	Au	Oxcu	Hem	Q	Cuarcita/Granodiorita	Gpo. Yura/Pampahuasi	Inactiva
165	Irma Nelida 2	Ica	29-m	8,409,822	482,188	Filoniano	Au	Au	Hem	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
166	La Isla 1	Ica	29-m	8,402,818	480,198	Filoniano	Au	Au	Hem	Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactiva
167	La Isla 2	Ica	29-m	8,402,878	480,198	Filoniano	Au	Au	Py,Hem	Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactiva
168	La Isla 3	Ica	29-m	8,402,878	480,198	Filoniano	Au	Au	Py,Lim	Q	Andesita porfirítica	Gpo. Camaná/Bella Unión	Inactiva
169	San Miguel	Ica	29-m	8,404,659	479,271	Filoniano	Cu,Au	Ml,Cris,Oxcu	Hem	Q	Cuarcita/Andesita	Gpo. Yura/Bella Unión	Inactiva
170	Yauricho	Ica	29-m	8,404,200	478,390	Filoniano	Cu,Au	Cp,Bo,Ml,Cris	Py,Hem	Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactiva
171	Denuncio Amarillo	Ica	29-m	8,408,748	480,250	Filoniano	Cu	Ml,Cris	Hem	Q,Ca	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
172	Tinguayoc - denuncio	Ica	29-m	8,407,993	479,798	Filoniano	Cu	Ml,Cris	Hem, Lim	Ca	Diorita/Cuarcita	Bella Unión/Gpo. Yura	Inactiva
173	Denuncio Capac Chico	Ica	29-m	8,412,356	494,396	Filoniano	Au	Oxcu	Hem	Q	Granodiorita	Tiabaya/Gpo. Yura	Inactiva
174	Prospecto Capac Grande	Ica	29-m	8,414,074	493,113	Filoniano	Au	Ml,Oxcu	Hem	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
175	Santuario I	Ica	29-m	8,404,401	487,368	Filoniano	Au	Au	Oxfe	Q,Ca	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
176	Tambo	Ica	29-m	8,405,162	487,328	Filoniano	Au	Au	Lim,Hem		Granodiorita	Tiabaya (Ks-mzgr/gdi)	Inactiva
177	Saramarca	Ica	29-m	8,397,666	490,483	Filoniano	Au	Cp,Bo,Ga	Hem	Q,Ca	Andesita porfirítica	Bella Unión/Gpo. Yura	Activa
178	Los Incas	Ica	29-m	8,413,997	449,949	Filoniano	Cu,Au	Cp,Bo,Cc,Ml,Cris	Hem	Q,Ca	Andesitas	Fm. Guaneros (Js-vs)	Inactiva
179	Minas	Ica	29-m	8,417,726	447,751	Filoniano	Cu,Au	Cp,Bo,Cc,Ga	Hem,Py	Q,Ca,Cln	Andesita/Monzonitico	Fm. Guaneros/Tiabaya	Activa
180	Cantera Serpiente 3	Ica	29-m	8,416,385	448,906	Filoniano	Cu	Cp	Lim,Hem		Calizas/Granodiorita	Fm. Guaneros/Tiabaya	Inactiva
181	Mina Nina Ccacca	Ayacucho	29-m	8,447,880	483,982	Filoniano	Au	Au	Lim,Hem		Piroclástico	Gpo. Camaná (PN-m)	Inactiva
182	Denuncio Puquio	Ayacucho	29-m	8,448,658	490,057	Filoniano	Au	Au	Lim,Hem		Piroclástico	Gpo. Camaná (PN-m)	Inactiva
183	Prospecto Mollecancha	Ayacucho	29-m	8,451,339	476,165	Filoniano	Au	Ml,Cris	Hem	Q	Monzotonalita	Incahuasi (Ki-gd/to-i)	Inactiva
184	Ornolloc	Ayacucho	29-m	8,451,371	475,572	Filoniano	Cu	Ml,Cris,Oxcu	Hem	Q	Monzonita	Incahuasi (Ki-gd/to-i)	Inactiva
185	Denuncio Temistocles	Ayacucho	29-m	8,432,024	459,441	Filoniano	Cu	Ml,Cris	Lim,Hem		Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva

Table 6 List of ore deposits and indications

N°	NOMBRE	DPTO	HOJA	COORDENADAS UTM NORTE	COORDENADAS UTM ESTE	TIPO DE YACIMIENTO	ELEM.	MINERAL METALICO PRINCIPAL	MINERAL METALICO ACCESORIO	MINERAL GANGA	ROCA CAJA	FORMACION GEOLOGICA	ESTADO
186	Chavez 8	Ica	29-m	8,428,908	456,677	Filoniano	Cu	Ml,Cris,Oxcu	Hem,Espe	Q,Cln	Monzodiorita	Linga(Ki-mzgr/gr)	Inactiva
187	Rescate	Ica	29-m	8,428,460	456,164	Filoniano	Cu	Ml,Cris,Oxcu	Hem,Espe	Q,Cln	Monzodiorita	Linga(Ki-mzgr/gr)	Inactiva
188	Chavez 2 - Concesión	Ica	29-m	8,429,449	455,098	Filoniano	Cu	Cp,Bo,Ml,Cris	Hem	Q,Cln	Monzodiorita	Linga(Ki-mzgr/gr)	Inactiva
189	Mina Chavez 2 - Unidad	Ica	29-m	8,426,600	455,269	Filoniano	Cu	Ml,Cris	Lim,Hem		Subvolcánico	Gpo. Casma (Kis-vs)	Inactiva
190	Camborda Mina	Ica	29-m	8,427,004	454,776	Filoniano	Cu	Ml,Cris	Hem, Lim	Ca	Subvolcánico	Gpo. Casma (Kis-vs)	Inactiva
191	Laura Cristina	Ica	29-m	8,427,272	454,958	Filoniano	Cu	Ml,Cris	Hem	Q	Andesita	Gpo. Casma (Kis-vs)	Inactiva
192	Chavez y Camborda	Ica	29-m	8,428,094	451,554	Filoniano	Cu	Cp.Cc,Ml,Cris	Hem,Py	Q	Subvolcánico	Gpo. Casma (Kis-vs)	Inactiva
193	Loropuquio	Ica	29-m	8,447,019	457,015	Filoniano	Cu	Ml	Py,Hem	Q	Cuarcita/Diorita	Gpo. Yura/Pampahuasi	Inactiva
194	Denuncio Llipapata	Ica	29-m	8,447,988	456,988	Filoniano	Au,Cu	Ml	Hem,Py	Q	Cuarcitas	Gpo. Yura/Pampahuasi	Inactiva
195	Mina San Francisco	Ica	29-m	8,446,084	455,387	Filoniano	Cu	No se observa	Hem, Lim	Ca	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
196	Huambina - denuncio	Ica	29-m	8,442,910	454,695	Filoniano	Cu	No se observa	Hem, Lim	Ca	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
197	Mina Santa María	Ica	29-m	8,443,580	452,841	Filoniano	Cu	Ml,Cris	Hem	Ca,Q	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
198	Palmerito	Ica	29-m	8,444,278	450,293	Filoniano	Au	Au	Oxfe	Or,Q	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
199	Santa Elena	Ica	29-m	8,442,240	446,878	Filoniano	Cu	Ml,Cris	Py	Q,Ca	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
200	Cancha Seca	Ica	29-m	8,438,867	454,112	Filoniano	Cu	Ml,Cris,Oxcu	Oxfe	Ca	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
201	Cabeza de negro	Ica	29-l	8,450,535	446,003	Filoniano	Cu,Au	Ml,Cris	Oxfe	Q,Cln	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
202	Jorihuayrana	Ica	29-m	8,415,336	478,958	Filoniano	Cu,Au	Ml,Cris	Lim	Q,Cln	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
203	Sotelo	Ica	29-m	8,414,300	479,442	Filoniano	Cu,Au	Ml,Cris	Py	Q,Ca	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
204	Unidad Piedra Pintada	Ica	29-m	8,419,384	477,231	Filoniano	Cu	Ml,Cris,Oxcu	Hem	Q	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
205	Mina Monta	Ica	29-m	8,432,083	482,682	Filoniano	Cu	Oxcu	Lim.Hem		Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
206	Mina Anita Tibillos	Ica	29-m	8,431,847	483,216	Filoniano	Cu	Ml,Cris	Lim,Hem		Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
207	Huarangal	Ica	29-m	8,442,578	481,906	Filoniano	Cu	Ml,Cris,Oxcu	Hem,Oxfe	Q	Tonalita	Incahuasi (Ki-gd/to-i)	Inactiva
208	Jalaorcco	Ica	29-m	8,443,083	481,045	Filoniano	Cu,Au	Oxcu	Hem,Oxfe	Q,Cln	Tonalita	Incahuasi (Ki-gd/to-i)	Inactiva
209	Huaranchayoc	Ica	29-m	8,443,386	480,910	Filoniano	Cu,Au	Oxcu	Py,Oxfe	Q	Tonalita	Incahuasi (Ki-gd/to-i)	Inactiva
210	Sumba	Ica	29-m	8,437,449	480,792	Filoniano	Cu,Au,Pb	Ml,Cris,Ga	Hem		Cuarcita/Tonalita	Gpo. Yura/Incahuasi	Inactiva
211	Incapchacra	Ica	29-m	8,434,552	477,843	Filoniano	Cu,Au,Pb	Cp,Ga	Py,Hem	Q	Cuarcitas	Gpo.Yura (JsKi-mc)	Inactiva
212	Iinachacra1	Ica	29-m	8,434,489	477,663	Filoniano	Cu,Au	Oxcu	Py,Hem		Tonalita	Incahuasi (Ki-gd/to-i)	Inactiva
213	Tinguayoc	Ica	29-m	8,407,685	478,647	Filoniano	Cu,Au	Ml,Cris	Hem	Q,Ca	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactiva
214	Locari	Ica	29-m	8,400,427	473,305	Filoniano	Cu,Au	Ml,Cris,Oxcu	Hem	Q	Andesita porfirítica	Bella Unión (Ki-an/da)	Inactiva
215	Piedra Pintada	Ica	29-m	8,421,929	475,817	Filoniano	Cu,Au	Ml,Cris		Q,Ca	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
216	Mina Piedra Pintada 1	Ica	29-m	8,421,952	475,809	Filoniano	Cu,Au	Ml,Cris	Hem	Q	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
217	Orongo	Ica	29-m	8,409,209	476,085	Filoniano	Cu	Cp,Bo,Az,Ml,Cris	Hem	Ca,Q,Cln	Diorita	Pampahuasi (Ks-gd/to-pa)	Inactiva
218	Mina Los Incas 1	Ica	29-m	8,414,000	449,358	Filoniano	Cu	Cp,Ml,Cris	Lim	Q,Ca	Andesitas	Fm. Guaneros (Js-vs)	Inactiva
219	Potrero	Ica	29-m	8,411,508	467,317	Filoniano	Au	Cp,Ml,Cris	Hem	Q	Monzodiorita	Linga(Ki-mzgr/gr)	Inactiva
220	Coquimbana	Ica	29-m	8,436,986	492,825	Filoniano	Au	Ga	Py	Q,Cln	Tonalita/Cuarcita	Tiabaya/Gpo. Yura	Inactiva
221	San Miguel	Ica	29-m	8,414,697	448,919	Filoniano	Cu	Cp,Bo,Cris	Py,Oxfe	Q, Ca	Granodiorita/Andesita	Tiabaya (Ks-mzgr/gdi)	Activa
222	Mina Lomo Largo	Ica	29-l	8,447,463	425,963	Filoniano	Au,Cu	Au,Cp,Ml	Hem, Lim	Q	Andesitas	Gpo. Casma (Kis-vs)	Inactiva
223	Mina Raquel	Ica	29-l	8,451,168	435,769	Filoniano	Au,Cu	Ml,Cris	Espe	Q,Cln	Monzonita	Linga(Ki-mzgr/gr)	Inactiva
224	San Pedro	Ica	29-l	8,451,274	435,760	Filoniano	Au,Cu	Cp,Ml,Cris	Espe,Hem,Py	Q	Monzonita	Linga(Ki-mzgr/gr)	Inactiva
225	Cansas	Ica	29-l	8,450,000	436,749	Filoniano	Au,Cu	Cp,Ml,Cris	Hem	Q	Monzonita	Linga(Ki-mzgr/gr)	Inactiva
226	Saya Saya (Umachulco)	Arequipa	31-r	8,318,556	779,173	Filoniano	Au	Au,teluros, Cu,Sph	Py	Q	Lavas andesiticas	Gpo. Barroso (NQ-v)?	Explor.
227	Orcopampa (Vetas Layo)	Arequipa	31-r	8,319,289	798,068	Filoniano	Au		Py	Q,Ser,Alu	Dacita	Gpo. Tacaza(Orcopampa)	Inactivo
228	Orcopampa (V.Santa Rosa)	Arequipa	31-r	8,293,851	787,603	Filoniano	Au	Ga,Sph,Sulf-Fe	Py-Sulf	Q,Ca	Areniscas	Gpo. Yura (Fm. Hualhuani)	Inactivo
229	Orcopampa (V. Calera Sur)	Arequipa	31-r	8,303,920	790,604	Filoniano	Au	Ttr,Ga,Cp,Sph,Pir,Bo	Py	Q,Rds,Ba,Ca	Lavas y Brechas	Gpo.Tacaza (PN-vs)	Activo
230	Ares	Arequipa	31-r	8,336,400	804,480	Filoniano	Au				Lava riodacita	Gpo. Barroso (NQ-v)	Activo
231	Chorunga (V. San Juan)	Arequipa	32-p	8,242,524	707,910	Filoniano	Au	Cp,Au,El,Ga,Sph,Bo,Cv	Py,Po,Jar,Hem	Q,Ca,Sid,Or	Granodiorita-Tonalita	Incahuasi (Ki-gd/to-i)	Activo
232	Chorunga (V. Mercedes)	Arequipa	32-p	8,242,524	707,910	Filoniano	Au	Au nativo, teluros, El	Py	Q	Granito-Granodiorita	Incahuasi (Ki-gd/to-i)	Activo

Table 6 List of ore deposits and indications

N°	NOMBRE	DPTO	HOJA	COORDENADAS UTM NORTE	COORDENADAS UTM ESTE	TIPO DE YACIMIENTO	ELEM.	MINERAL METALICO PRINCIPAL	MINERAL METALICO ACCESORIO	MINERAL GANGA	ROCA CAJA	FORMACION GEOLOGICA	ESTADO
233	Chorunga (Clarita Stock)	Arequipa	32-p	8,236,621	713,729	Stock work	Au,Cu	Au diss, Cu ??	Sulf	Q	Granito-Granodiorita	Incahuasi (Ki-gd/to-i)	Inactivo??
234	Chorunga (Clarita-Vetas)	Arequipa	32-p	8,236,420	713,503	Vetiforme	Au,Cu	Au diss, Cu ??	Sulf., oxidos	Q	Limoarcillas	Gpo.Yura (JsKi-mc)	Activo??
235	Chorunga (Erika)	Arequipa	32-q	8,234,544	715,507	Stock work	Au,Cu	Au nativo, Carcu	Py	Q	Granito-Granodiorita	Incahuasi (Ki-gd/to-i)	Inactivo
236	Chalhuane	Arequipa	32-q	8,240,417	722,139	Diseminado	Au-Cu	Au nativo,Cu	Py	Q,Epi,Carb	Tonalita-Sediment	Incahuasi (Ki-gd/to-i)	Inactivo
237	Misky	Arequipa	32-r	8,233,700	793,750	Filoniano	Au,Cu?	Au	Py	Q	Granodiorita-Diorita	Incahuasi (Ki-gd/to-i)	Activa
238	Huaca	Arequipa	32-p	8,233,487	699,168	Filoniano	Au				Basalto	Complejo Basal de la Costa	Inactiva
239	Sauce-Fortuna	Arequipa	32-p	8,237,917	699,275	Filoniano	Au?	Bo,Cp,Ga	Py,Ars,Po	Q	Granodiorita	Incahuasi (Ki-gd/to-i)	Inactiva
240	Coropuna (Pucahilla)	Arequipa	32-q	8,276,085	744,206	Diss,vetillas	Au,Ag?		Lim	Q,Arc	Brecha	Gpo.Tacaza (PN-vs)	Inactivo
241	Tororumi (Tororumi)	Arequipa	32-p	8,277,046	686,579	Filoniano	Au,Cu?	Au,teluros, Cu	Py-Sulf	Q	Granito	Tiabaya (Ks-mzgr/gdi)	Inactivo
242	Chipmo (Proy. Claudia)	Arequipa	31-r	8,311,411	779,802	Filoniano	Ag,Au			Q,Arc	Dacita	Gpo.Tacaza (PN-vs)	Activo
243	Chipmo (Proy. Sta. Maria)	Arequipa	31-r	8,308,796	781,642	Filoniano	Au	Ga	Py	Q,Ba,Arc	Brecha	Gpo.Tacaza (PN-vs)	Activo
244	Chipmo (Veta Prometida)	Arequipa	31-r	8,311,034	782,349	Filoniano/St-	Au	Au,teluros		Q,Alu,Pirof	Tobas	Gpo.Tacaza (PN-vs)	Activo
245	Shila (Proy. Chinchon)	Arequipa	31-r	8,305,595	800,944	Diseminado	Au,Ag		Py	Q,Alu	Brechas	Gpo. Barroso (NQ-v)?	Inactivo
246	Shila (Proy. Chuañuma)	Arequipa	31-r	8,298,724	795,500	Filoniano	Au,Ag			Q	Lavas	Gpo. Barroso (NQ-v)?	Activo
247	Mina Paula (Vetas Nazareno	Arequipa	31-r	8,288,145	810,727	Filoniano	Au,Ag?	Ag,Ttr,Sph, Ga	Sulf	Q	Brechas	Gpo. Barroso (NQ-v)?	Activo
248	Paula (Area Neck)	Arequipa	31-r	8,288,211	811,880	Filoniano	Au,Ag?	Ag,El,Sph,Cp,Ga,En	Py	Q,Rod,Rds,Ad	Brechas y lavas	Gpo. Barroso (NQ-v)	Activo
249	Tinoray (Veta California)	Arequipa	32-p	8,246,211	695,305	Filoniano	Au,Cu,Ag		Py	Q,Arc	Granodiorita	Incahuasi (Ki-gd/to-i)	Activa
250	Tinoray (Chimenea Tinoray)	Arequipa	32-p	8,246,313	695,785	Filoniano	Au,Cu,Ag		Oxfe,Py,hem	Q	Granodiorita	Incahuasi (Ki-gd/to-i)	Activa
251	Tinoray (Proy. Centromin)	Arequipa	32-p	8,243,633	691,793	Filoniano	Au,Cu,Ag	Au,Te,Sulf y Sufsal		Q	Granodiorita-Monzonita	Incahuasi (Ki-gd/to-i)	Activo
252	Tinoray (Veta Poderosa)	Arequipa	32-p	8,242,632	690,689	Filoniano	Au,Cu,Ag			Q	Granodiorita-Monzonita	Incahuasi (Ki-gd/to-i)	Activo
253	Iruyoc	Arequipa	32-r	8,253,180	809,634	Mantiforme	Cu, Au	Ml, Cris	Hem, Lim	Ca, Gyp	Areniscas calcareas	Fm. Seraj (Ks-m)	Inactivo
254	El Gallo	Arequipa	32-r	8,267,935	805,284	Filon-mantif	Au	Ga,Cup	Py,Lim	Q	Gneis	Complejo Basal de la Costa	Inactivo
255	Ajpi (Piucirca)	Arequipa	32-r	8,273,810	814,690	Filoneano	Au	Au,Ga, Sph	Py, Lim		Gneis	Complejo Basal de la Costa	Inactivo
256	Piraucho	Arequipa	32-r	8,266,038	780,470	Filon-metaso	Au	Ga	Py, Lim	Jar, Q	Andesita - Adamelita	Fm Arcurquina (Kis-m)	Inactivo
257	Toncoro	Arequipa	32-r	8,283,050	795,731	Filoneano	Au	Au	Espe	Q,Ca	Areniscas - Calizas	Gpo.Yura (JsKi-mc)	Inactivo
258	Úrsula 1	Arequipa	32-r	8,270,000	806,600	Filoneano	Au,Ag,Cu	Cp	Py,Lim	Q	Granodiorita, Andesita	Tiabaya (Ks-mzgr/gdi)	Inactivo
259	Jarahualli	Arequipa	32-p	8,257,329	671,132	Filoneano	Au,Ag	Au,Sufsal	Hem,Py	Q	Granodiorita	Linga(Ki-mzgr/gr)	Activo
260	Ishihuinca	Arequipa	32-p	8,252,143	671,674	Filoneano	Au,Cu,Ag	Au,Sulf	Hem,Lim	Q	Granodiorita	Tiabaya (Ks-mzgr/gdi)	Activo

Abbreviation

Act actinolite
Ad adularia
Ag silver
Alu alunite
Arc clay
Ars arsenopyrite
Atac atacamite
Au gold
Az azurite
Ba barite
Bo bonite
Br brocantite
Ca calcite
Carcu Cu carbonate
Cc chalcocite
Cl chlorite

Cln caolinite
Cp chalcopyrite
Cris crysocola
Cu copper
Cup cuprite
Cv covelline
El electrum
En enargite
Epi epidote
Espe specularite
Fe iron
Ga galena
Gth goethite
Gyp gypsum
Hem hematite
Jar jarosite

Lim limonite
Mag magnetite
Mar marcasite
Ml malachite
Mo molybdenite
Mrt marmatite
Or orthclase
Oxcu copper oxide
Oxfe iron oxide
Oxmn manganese oxide
Pb lead
Po pyrrhotite
Pirof pyrophyllite
Py pyrite
Pyau Au bearing pyrite
Q quartz

Rds rhodochrosite
Rod rhodonite
Sid siderite
Sph sphalerite
Sulf sulfide
Sufsal sulfosalt
Te telurium
Tre tremolite
Ttr tetrahedrite
Tur tormaline

diss dissemination
filon filoniano
mantif mantiforme
metaso metasomatico
veti vetiforme

coast toward the interior, Paracas-Chala, Mala-Nazca, Nazca-Ocoña and Puquio-Caylloma. The Paracas-Chala Zone on the Pacific coast corresponds to the above-referred iron ore zone, being situated in the Precambrian and Paleozoic fold zone. The Mala-Nazca and Nazca-Ocoña Zones situated in the inner zone correspond to the copper and gold ore zones and are derived from intrusive rocks piercing folded Mesozoic rocks. The Puquio-Caylloma Zone corresponds to the polymetallic sub-province and is defined as the metallogenic zone related to volcanic rocks originating in the post-orogenic movement. The Estudio de Recursos Minerales por Franja in 2001 (Franja 2) has verified the locations of 260 known ore deposits and indications in the survey area. Fig.15 exhibits the locations of occurrence, while their respective summaries are tabulated in Table 6.

Table 7 indicates the known ore deposits and indications classified by mineralization type and country rock. Vein-type ore deposits found at 238 localities make up a great majority, followed by manto-type deposits at 15 localities, 14 of which are ore bodies constituting the Marcona iron mine. Ore indications of dissemination type found at four localities and stock-work type deposits at three localities are also referred to. Characteristics of the ore indications by type of ore deposit inferred from the existing data are summarized in the following paragraphs.

2-4-1 Vein Type Ore Deposits

(1) Vein-type Au deposits

This category, including gold and silver-bearing veins, is most frequently seen of all the vein-type deposits; ore indications at 94 localities are described. Country rocks of these veins are mostly the coastal batholith (38 localities), followed by Mesozoic sedimentary rocks (25), the Bella Union Complex (16), Cenozoic volcanic and sedimentary rocks (12), the Basal Complex (4) and unknown country rocks (1). The ore deposits are small in size, averaging 0.3m in width and rarely exceeding 1m. Though little descriptions are given on the length, these veins are several decameters to several hundred meters long. In terms of trend, veins with the Andean trend, or NW-SE, are found at 28 localities, the most of the 67 ore indications whose strike and dip are described, which are followed by those trending NE-SW (15), and by EW and NS (12 each). As regards the dip, veins dipping steeply (50-70°) are dominant, followed by those of gentle dip (20-40°). The relationship between the strike-dip and the size of ore deposits is that veins wider than 1m dominantly trend NW-SE and are of rather steep dip. Native gold, electrum, gold-bearing pyrite, sulfate minerals, chalcopyrite, galena, sphalerite, bornite, covellite, tetrahedrite, cuprite, malachite, chrysocolla, arsenopyrite, pyrrhotite, marcasite, specularite, hematite, limonite, etc. are described as the ore minerals. The described gangue minerals are mainly quartz and calcite, with subordinate amounts of sericite, halotrichite, gypsum, kaolin, rhodochrosite, rhodonite, alunite, adularia, orthoclase and clay.

(2) Vein type Au/Cu ore deposits

The category includes copper-gold vein deposits, as well. Deposits of this category are found at 79 localities, the second most after the gold vein deposits. Country rocks of these veins at 34 localities are Mesozoic sedimentary rocks, followed by the coastal batholith at 32 localities, which altogether account for 84% of all. With the Bella Union Complex (11 localities) added, almost all the ore indications of this category are embedded in Mesozoic sedimentary or intrusive rocks. These vein deposits are small in size, averaging about 0.5m in width. Veins wider than 1m are found at eight localities out of the 43 indications whose widths are described, which suggests that veins of this category is a little larger in size than the foregoing veins of gold alone. Though little descriptions are given on the vein lengths, these are several decameters to several hundred meters long. As for the trend, veins trending NW are found at 24 localities, or a half of the 49 indications whose strike and dip are described, followed by those

Table 7 Relationship between wall rocks and mineralization

		Pre-Mesz. Era			Mesozoic Erathem								Cenozoic Erathem				Mesozoic Intrusives								Cenz. Intrusiv			
																		Costal Batholith										
		Comp. Basal	Fm. Marcona	Total	Fm. Chocolate	Fm. Guaneros	Gp. Yura	Gp. Casma	Fm. Pariatambo	Fm. Arcurquina	Fm. Seraj	Total	Gp. Tacaza	Gp.Cmamná	Gp. Barroso	Total	Bella Union	Patap	Linga	Pampahuasi	Incahuasi	Tiabaya	Subtotal	Total	Dacite	Unknown	Total	Grantotal
Vetiforme	Au	4	–	4	1	4	16	–	1	1	–	23	4	3	5	12	16	4	7	1	4	22	38	54	–	1	1	94
	Au·Cu	–	–	–	–	9	9	1	–	–	–	19	–	–	–	–	3	–	3	–	5	7	15	18	1	–	1	38
	Cu·Au	–	–	–	–	4	7	4	–	–	–	15	–	–	–	–	8	1	–	5	3	8	17	25	–	–	–	40
	Subtotal	–	–	–	–	13	16	5	–	–	–	34	–	–	–	–	11	1	3	5	8	15	32	43	1	–	1	78
	Cu	–	–	–	–	2	7	5	1	–	–	15	–	–	–	–	4	–	22	10	2	3	37	41	–	–	–	56
	Cu·Fe	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	2	–	–	–	2	2	–	–	–	3
	Fe	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	–	–	–	–	6	6	–	–	–	6
	Ba	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
	Total	4	–	4	1	20	39	10	3	1	–	74	4	3	5	13	31	11	34	16	14	40	115	146	1	1	2	238
Mantiforme	Fe	–	12	12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
	Fe·Cu	–	1	1	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
	Cu·Au	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
	Total	–	13	13	–	1	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
Diseminado	Au·Ag	–	–	–	–	–	–	–	–	–	–	–	1	–	1	2	–	–	–	–	–	–	–	–	–	–	–	2
	Au·Cu	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	–	–	–	1
	Cu·Mo	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	1	–	–	–	1
	Total	–	–	–	–	–	–	–	–	–	–	–	1	–	1	2	–	1	–	–	1	–	2	2	–	–	–	4
Stk.work	Au·Cu	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2	2	–	–	–	2
	Au	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
	Total	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	2	–	2	2	–	–	–	3
Grantotal		4	13	17	1	21	39	10	3	1	1	76	7	3	6	16	31	12	34	16	17	40	119	195	1	1	2	260

trending NE (15), EW (6) and NS (4). The tendency of occurrence is similar to that of the gold vein deposits. Veins with rather steep dip (50-70°) are dominant, followed by those with gentle dip (20-40°). The relationship between the strike-dip and size of ore deposits is that veins wider than 1m are prevalent in those trending NW-SE (5 localities), followed by NE-SW (2) and EW (1), while dominant in those dipping rather steeply (60-70°). Chalcopyrite, bornite, native gold, gold-bearing pyrite, chalcocite, oxide copper ores such as malachite and chrysocolla, specularite, hematite, limonite, etc. are described as the ore minerals. The described gangue minerals are chiefly quartz and calcite, with subordinate amounts of kaolin, chlorite, halotrichite, gypsum, epidote, tourmaline, actinolite and tremolite.

(3) Vein Type Cu ore deposits

Fifty-six (56) ore indications of this category are described. Country rocks of 37 ore indications are described in the Coastal Batholith, 22 of which are found in the Linga Super-unit. Country rocks occur at 15 localities in Mesozoic sedimentary rocks and at four localities in the Bella Union Complex; practically all the ore indications of this category are embedded in Mesozoic formations or intrusive rocks. These indications are somewhat larger in size than those of the foregoing two categories. The average vein width of the 36 indications whose widths are described is about 0.6m and veins wider than 1 m are found at nine localities. As regards trend of veins, those trending NW account for 26 out of the 41 indications whose strike and dip are described, followed by NE-trending veins (10), NS (3) and EW (2). This appearance tendency is similar to that of the gold vein deposits. Compared with the gold-copper vein deposits, the appearance frequency of the EW trend and the NS trend is reversed; however, if the difference in appearance frequency from the NW and the NE is taken into account, it can be said that the tendency is similar. About a half of the veins dip rather steeply (50-70°), followed by those of steep dip (80°more), while those of gentle dip (20-40°) are very few. Regarding the relationship between strike-dip and size of ore deposits, six out of the nine indications wider than 1m trend NW and dip rather steeply, whilst a NW-trending vein and a EW-trending one, both dipping rather steeply, are described. The ore minerals described are chalcopyrite, bornite, cuprite, chalcocite, covellite, azurite, malachite, chrysocolla, atacamite, pyrite, specularite, hematite, limonite, magnetite, pyrrhotite, etc., while quartz, calcite, kaolin, tourmaline, actinolite, gypsum, halotrichite, etc. are described as the gangue minerals.

(4) Vein Type Cu/Fe ore deposits

Ore indications of this category are described at three localities. Descriptions on country rocks are given to two indications in the Linga Super-unit, which composes the Coastal Batholith and to an indication in the Guaneros Formation of the Mesozoic. As regards strike and dip, two indications trending NNE and steeply dipping (N20-25°E; 85°NW or SE) and an indication trending NNW and gently dipping are described, all of which are less than 1m wide. The ore minerals are oxide copper ores such as malachite, chrysocolla and brochantite, magnetite, hematite and goethite, while quartz, calcite, chlorite, etc. are described as the gangue minerals.

(5) Vein Type Fe ore deposits

Six ore indications are described. All these indications are found in the Acari Diorite (classified into the Patap Super-unit in this Report) lying in the southeast of the Marcona iron ore deposits. Although the relationship with the Marcona deposits has not been clarified, the both are similar in the mineral composition while differ only in the country rocks. The country rocks hosting ore deposits of this category are diorite to granodiorite.

The veins are 1m to 40m wide and 200m to 1500m long. Two NE-SW trending indications, two EW- and one NS-trending indications are described. The EW trending indications are nearly vertical, a little dipping south, those trending NE dip 75°N and that trending NS is vertical. The ore minerals are magnetite and hematite, while the gangue minerals are quartz, actinolite, phosphorous minerals, etc.

(6) Vein Type Ba ore deposits
Ore indication is described at a locality, whose country rocks are quartzite in the Pariatambo Formation. The ore mineral is barite while quartz is the gangue. Detailed descriptions are lacking on the deposits of this category.

2-4-2 Manto Type Ore Deposits

(1) Manto type Fe ore deposits
Ore bodies are described at 12 localities, all of which compose the Marcona deposits, the only operating iron mine in Peru. These bodies lie in the Paracas-Chala Metallogenic Zone. The iron ore deposits in the neighborhood of Marcona had been interpreted as Jurassic hydrothermal metasomatic deposits in the Marcona and the Guaneros Formations originating from the adjacent San Nicolas Batholith. At present, however, the relationship with the batholith has been denied as the result of the radioactive dating of the batholith, and the bodies are inferred to originate from Mesozoic pinkish dacite dikes and sheets. There is also a view based on the theory of syngenesis that the bodies in the Guaneros Formation are those remobilized from the Marcona Formation.
The ore bodies lie, in tabular forms almost concordantly with the strata, in limestones and dolomites of the Marcona Formation and in limestones and calcareous sandstones of the Guaneros Formation. Generally, the ore bodies strike E-W to NE-SW.
Ores of the Marcona Mine are prevalently magnetite with a subordinate amount of pyrite, The ore minerals represents zonal distribution in the vertical direction. The upper part is a leached oxidation zone lying near the surface, composed of residual magnetite, occasionally accompanied by oxides of copper, carbonates and also marmatite. The middle part is composed mainly of residual magnetite, and there are transition zones with pyrite partially changing to hematite, accompanied by halotrichite. In the lower part, lies a primary zone composed of microcrystalline magnetite, accompanied by the gangue such as actinolite, quartz, sericite, epidote, gypsum, etc.

(2) Manto type Fe/Cu ore deposits
Two ore indications are described, one at the Marcona Formation and the other at the Guaneros Formation. The latter is described as 3.8m wide, striking N-S and dipping 5°E. The ore minerals are magnetite, pyrrhotite, hematite, specularite, chalcopyrite, chrysocolla, brochantite, pyrite, etc., while the gangue minerals are quartz, gypsum and actinolite.

(3) Manto type Cu/Au ore deposits
An ore indication is described in calcareous sandstones of the Seraj Formation of the Meozoic, which is 0.5m wide, striking E-W and dipping 24°S. The described ore minerals are malachite, chrysocolla, hematite, limonite, etc., while the gangue minerals are calcite and gypsum.

2-4-3 Dissemination Type Ore Deposits

Four indications of this category are described, which are gold-silver type at two localities, gold-copper and copper-molybdenum types at a locality each. Two dissemination-type Au-Ag indications are described in breccia in the Tacaza Group of the Miocene and the Barroso Group of the Pleistocene, the former being 1km x 4.5km while the latter being 110-180m x 250m. The ore mineral is limonite while the gangue minerals are quartz, alunite and clay minerals.

A dissemination-type Au-Cu indication is described in tonalite of the Incahuasi Super-unit, which is relatively large in size, 4km x 4.5km. The described ore minerals are native gold, copper minerals and pyrite while the gangue minerals are quartz, carbonate minerals and epidote.

Cu-Mo dissemination-type indications are situated in the sections assigned to the unclassified basic body of the Coastal Batholith, which is tentatively reclassified in this Report into the Patap Super-unit, from the lithological point of view. Granodiorite is described as the country rocks. The indication is 400m x 2,000m in extension, striking N45°E. The ore minerals are chalcopyrite, carbonate copper ore, hematite, oxide manganese ore, accompanied by quartz as the gangue.

2-4-4 Stockwork Type Ore Deposits

Three ore indications of this category, gold-copper indications at two localities and gold indication at a locality, have been ascertained.

The network-type gold-copper indications are hosted by granite to granodiorite of the Incahuasi Super-unit, and associated with veinlets, 0.4-0.5m wide, striking N80°E and dipping 65°SW. The ore minerals are native gold, copper minerals, carbonate copper ores and pyrite while quartz is the gangue mineral.

The network-type gold indication lies in tuff of the Tacaza Group of the Miocene. The ore minerals are native gold and tellurium minerals while quartz, alunite and pyrophyllite are the gangue minerals.

2-4-4 Respective Ore Deposits

The descriptions of respective indications and deposits are summarized in the Appendix 1 at the back of this Report. The summaries only of major mines are excerpted in the following paragraphs.

(1) Marcona Mine (Table 6, No.1 to 14)
Location: Prov. Marcona, Dist. Nazca, Dept. Ica
UTM coordinate - 8,320,450N, 487,150E ; altitude - 800m
Concession owner: Shougang Hierro Peru S.A.
Production (1999): 2,672,000 long ton (metal content)
Proven Ore reserves (end 2001): 858,655,000 m.ton (Fe 55.3%, Cu 0.12%, S 2.56%)

Precambrian metamorphic rocks, Cambrian marine sedimentary rocks, Jurassic continental meta-sedimentary and meta-volcanic rocks are pierced by granodiorite of the coastal batholith. These rocks are underlain by tuff which intercalates sedimentary rocks of the Cretaceous age after mineralization and semi-consolidated sedimentary rocks of the Tertiary age, which are pierced by dike rocks of younger ages.

The ore deposit lies in horizons of limestone and dolomite in the Marcona Formation of the Cambrian age, concordantly with the strata, while only minor parts of the deposit are embedded concordantly with the strata in the Guaneros Formation of the Jurassic age.

The ore bodies trend NE-SW and dip 35-65°NW. The proven ore bodies total 117 and the area of occurrence of the bodies covers approximately 10km x 10km. The ore mineral is magnetite while the gangue minerals are actinolite, calcite, quartz and apatite. Magnetite is crystallized immediately following actinolite, associated with quartz and calcite, and impregnated with pyrite. Pyrite is altered to limonite while actinolite is altered to serpentine and talc, and magnetite is partially oxidized and altered to hematite. During the alteration processes, iron sulfate minerals, gypsum, anhydrite, etc. were formed.

The combination of ore minerals varies in the vertical direction. The upper part is an oxidation zone mainly with hematite, partially accompanied by residual magnetite and also by oxide and carbonate copper ores. The gangue minerals are apatite and calcite. Bonanzas grading Fe 65% are occasionally formed. The lower part is made up of cryptocrystalline, fine-grained magnetite associated with actinolite, sericite, epidote and gypsum, while apatite gradually increases downward.

(2) Orcopampa Mine (Table 6, No.299)
Location: Prov. Orcopampa, Dist. Castilla, Dept. Arequipa
UTM coordinate - 8,303,920N, 790,604E ; altitude - 3,890m
Concession owner: Cia Minas Buenaventura S.A.A.
Production (2000): Crude ore 255,400 s.ton (Ag 293,000oz, Au 96,843oz; Cu 59s.ton)
Exploration (2000) Tunnelling 4,705m; drilling 17,725m; acquired ore reserves 342,200 s.ton
Proven ore reserves (2001): 171,700 m.ton (Ag 0.6 oz/s.t; Au 0.466 oz/s.t)
The country rocks are volcanic breccia and lavas of the Tacaza Group. The ore deposit is composed of parallel veins with the trend of normal faults striking E-W and dipping nearly vertically, originating from adularia-sericite type mineralization accompanied by silicification, argillization and propylitization. The ore minerals are tetrahedrite, enargite, galena, chalcopyrite, sphalerite, pyrargyrite, bornite, native gold, etc., while the gangue minerals are quartz, rhodochrosite, barite, calcite, etc.
The radioactive dating of the Calera vein indicates 16.5 m.y.

(3) Shila Mine (Table 6, No.246)
Location: Prov. Chachas, Dist. Castilla, Dept. Arequipa
UTM coordinate - 8,298,724N, 795, 500E ; altitide - 4,870m
Concession owner: Minera Shila S.A.C.
Production (2000): Crude ore 51,700 s.ton (Ag 346,500 oz, Au 23,510 oz)
Exploration (2000): Tunneling 4,813m; drilling 9,956m; acquired ore reserves 68,900 s.ton
Proven ore reserves (as of end 2001): 33,900 m.ton (Ag 9.5 oz/ m.ton, Au 0.468 oz/ m.ton)
Andesitic lavas of the Barroso Group of the Pleistocene are the country rocks. The ore deposit is an epithermal vein-type deposit accompanied by silicification.

(4) Ishihuinca Mine (Table 6, No.261)
Location: Prov. Caraveli, Dist. Caraveli, Dept. Arequipa
UTM coordinate - 8,252,143N, 671,674E ; altitude - 1,990m
Concession owner: Inversiones Mineras del Sur S.A.
Proven ore reserves (as of end 2001): 81,700 m.ton (Au 13.07 g/m.ton)
The country rock is granodiorite of the Tiabaya Super-unit, which has fractures trending NW-SE and NE-SW. The deposit is composed of 16 veins striking N45°E on average and dipping 70°NW. The veins are 1.5m wide on average and 1km long and composed of acidic dikes and milky white quartz veins, accompanied by hematite, limonite, pyrite, chalcopyrite, sulfide minerals, etc. The acidic dikes are made up of quartz (73%), plagioclase (5%), muscovite (2%), tourmaline (1%), opaque minerals (10%), sphene, etc. The analysis of ore samples taken at the time of field verification is Au 8.25 g/t.

(5) Ares Mine (Table 6, No.230)
Location: Prov. Orcopampa, Dist. Castilla, Dept. Arequipa
UTM coordinate - 8,336,400N, 804,480E ; altitude - 4,900m
Concession owner: Cia. Minera Ares S.A.C.
Proven ore reserves (as of end 2001): 364,000 m.ton (Au 25.51 g/m.t, Ag 6.15 oz/m.t)

The country rocks are andesite and rhyolite of the Miocene Tacaza Group, tuff, agglomerate, breccia and andesite of the Alpabamba Formation, and andesitic to ryolitic lavas of the Barroso Group of the overlying Quaternary. Fractures and veins of three trends are observed.

Trend ;	Veins
N60W :	Guadalupe, Claudia, Tania, Diana
N50E :	Victoria, Maruja, Lula
N-S :	NS

These veins are of simple cymoid structure, originating from low sulfidation Au-Ag mineralization, and form high-grade ore bodies.

(6) Chorunga Mine (Table 6, No. 231)
Location: Prov. Grande, Dist. Condesuyos, Dept. Arequipa
UTM coordinate - 8,242,524N, 707,910E ; altitude - 1,500m
Concession owner : Cia. Minera Erika S.A.
Proven ore reserves (as of end 2001): 31,200 m.ton (Au 8.31 g/m.t)
The country rocks are grayish white, medium- to coarse-grained granodiorite to tonalite of the Incahuasi Super-unit. The deposit is cut by numerous faults and fissures and pierced by numerous neutral to basic dikes. Hydrothermal potassification is remarkable, accompanied by silicification and chloritization. In the faults near the ore deposit, activity before and after mineralization is discernible. The faults strike N60-85°W and dip 60-75°N or S. These faults not only serve as the passages of ore-forming fluid but constitute the principal ore bodies. Veins are 0.4 to 1.8m wide. The ore minerals are pyrite, chalcopyrite, pyrrhotite, native gold, electrum, galena, sphalerite, bornite, covellite, malachite, hematite, goethite, limonite, etc. The gangue minerals are white to pinkish gray quartz, calcite, siderite, orthoclase, etc.

(7) Paula Mine (Table 6, No.248)
Location: Prov. Choco, Dist. Castilla, Dept. Arequipa
UTM coordinate - 8,288,211N, 811,880E ; altitude - 5,200m
Concession owner: Minera Paula 49 S.A.C.
Proven ore reserves (as of end 2001): 62,500 s.ton (Au 0.565 oz/s.t, Ag 4.1 oz/s.t)
The country rocks are tuff breccia of the Barroso Group of the Pleistocene, lavas and andesitic intrusive rocks, in which three types of hydrothermal alteration is distinguishable.
- Potassification of feldspathic microlite
- Replacement of biotite and hornblende pseudomorphs with chlorite-epidote-calcite aggregate and, partial replacement of plagioclase with sericite and calcite
- Sericitization of the whole country rocks, which is accompanied by quartz, pyrite and a subordinate amount of calcite

The ore minerals are silver-bearing tetrahedrite, polybasite, argentite, acanthite, pyrite, sphalerite, chalcopyrite, galena, electrum, enargite, etc. The gangue minerals are rhodonite, rhodochrosite, adularia, etc.

2-5 Considerations

The survey area is underlain by Precambrian to Quaternary sedimentary and volcanic rocks and their metamorphics extending in the NW-SE direction. These rocks are intruded by Ordovician to Silurian, Cretaceous to Paleogene, and Neogene intrusive rocks. Megascopically, the geological setup in the survey area maybe outlined as follows: The southwestern to eastern part of the area is underlain by the Precambrian metamorphic rocks, which are gradually replaced northward by sedimentary and volcanic rocks of younger ages.

The area is rezoned, from the pacific coast toward the interior, into the Metallogenic Zones of Paracas-Chala, Mala-Nazca, Nazca-Ocoña and Puquio-Caylloma. Correlated with the traditional metallogenic provinces of Peru, the Paracas-Chala corresponds to the cupreous sub-province and the coastal iron-copper ore zone, the Mala-Nazca to the copper ore zone, the Nazca-Ocoña to the cupreous sub-province and gold-copper ore zone, and the Puquio-Caylloma to the Western Andes polymetallic sub-province, respectively.

The ore deposits and indications at 261 localities have been described in the second-year study of the Estudio de Recursos Minerales por Franja, which is currently under implementation in accordance with the INGEMMET's long-term program. Vein-type deposits account for 239 out of the 261 localities described, 173 of which are gold and gold-copper vein deposits. This strongly reflects the characteristics of the Nazca-Ocoña Metallogenic Zone. The copper vein deposits at 56 localities reflect the characteristcis of the Mala-Nazca Zone. Manto-type deposits are described at 15 localities, 12 of which are iron ore deposits while two are iron-copper deposits, all constituting the Marcona ore deposits, the only operating iron mine in Peru. In the surrounding area, iron vein deposits at six localities and iron-copper vein type deposits at three localities are described, which demonstrate the characteristics of the Paracas-Chala Metallogenic Zone. Besides, dessimination-type deposits at four localities and network-type deposits at three localities are known. Dissemination-type deposits at two localities and a network-type deposit lie in Cenozoic volcanic rocks in the Puquio-Caylloma Metallogenic Zone.

From the viewpoint of the combination of ore minerals, it is considered highly significant that ore indications of gold alone are found in Cenozoic volcanic rocks, because it inferably suggests existence of gold mineralization originating in new volcanic rocks. The fact that the country rocks of these ore indications are found in the Tacaza and Camana Groups of the Miocene and the Barroso Group of the Pleistocene indicates that gold mineralization has continued from the Miocene to the Recent time. Signs of the Recent mineralization can be read from the analysis of travertine (Au 0.05ppm, Ag 0.7ppm, As 2,041ppm, Fe 25.3%, etc.) of the Viques thermal springs in the eastern part of the survey area (Quad. 32-p), as stated in the report on the geothermal activity in the Caylloma-Puquio region. For reference, the Viques thermal springs, situated at an altitude of 3,450m, originate from the fractures which cut the Barroso Group (Water temperature 25℃; volume 30 liter/min; pH 3.5; and, accompanied by hydrogen sulfide gas).

It is considered necessary to inquire into the possibility that presence of gold deposits in Mesozoic sedimentary rocks is an indication of stratabound ore deposits. Concerning stratabound ore deposits, phenomena such as migration and/or reconcentration of component metals caused by posterior geologic movement are generally known. In addition, comprehensive study and analysis on such themes as combination of metallic minerals contained, types of associated gangue minerals, temperatures of ore formation, etc. are required. A manto-type copper-gold indication, though small in size, is described in the Mesozoic Seraj Formation. Presence of vein-type deposits of gold alone as a possible indication of stratabound ore deposits is also considered to be a theme worthy of study.

Except the Marcona Mine, the ore deposits and indications in the survey area have been little studied from the metallogenic point of view. From the analysis of existing data and locations of the ore indications, mineralization in the survey area can be typified as follows.

- Manto-type and vein-type iron (-copper) deposits related with andesitic intrusive bodies of the latest Miocene

- Gold, gold-copper and copper vein deposits related with the Coastal Batholith of the end of the Cretaceous to the beginning of the Paleogene
- Vein-type, dissemination-type and stockwork-type gold deposits related to Miocene to Recent volcanic rocks

In the light of the analysis of the existing data, the requisites for extraction of areas to be studies may be condensed as follows.

(i) Areas of occurrences of gold and gold-copper indications that overlap areas underlain by Miocene to Recent volcanic rocks; and,
(ii) Areas of occurrences of gold indications that overlap areas underlain by Mesozoic volcanic and sedimentary rocks, in which stratabound deposits are likely to be embedded.

Chapter 3 Integrated Analysis

The satellite image analysis has revealed that locations of occurrence of vein-type deposits are unrelated with lineament density. In case of a vein-type deposit lying in Mesozoic rocks, it is not clear if it is related with the iron oxide index and the clay minerals index, whereas a vein-type deposit lying in Cenozoic rocks is always accompanied by anomalies in either of the indices. As regards dissemination-type and network-type deposits, it has been concluded that these deposits occur in the vicinity of relative elevations of lineament density and anomalies in either of the indices, though weak, are found at the locations of occurrence.

As the result of the analysis of existing geologic information, it has been concluded that a high priority should be given to verification of characteristics of vein-type indications of gold alone that lie in geologic units possibly hosting stratabound deposits, which are extracted from among vein-type indications inferably originating from gold mineralization related with Miocene to Recent volcanic rocks or from intrusive rocks of the end of Cretaceous to the beginning of Paleogene age.

The results of the satellite image analysis and the analysis of the existing geologic information were integrated with the aid of the GIS, whereby an integrated analysis map has been drawn. The map indicates the results of the respective analyses which follow (Fig. 16 and the attached Plate 1).

(i) Locations of the known ore deposits and indications
(ii) Distribution of country rocks
(iii) Distribution of lineament density
(iv) Anomalies in the R21 (iron oxide index)
(v) Anomalies in the R57 (clay minerals index)

Based on the integrated analysis, areas of interest were extracted from the entire survey area. For the selection of areas of interest, the following criteria were used:

(i) Areas of concentration of R21 anomalies extracted by the satellite image analysis
(ii) Areas of concentration of R57 anomalies extracted by the satellite image analysis
(iii) Areas of high lineament density
(iv) Areas underlain by Miocene to Pleistocene volcanic rocks that can be country rocks of new gold mineralization/alteration and by the Guaneros Formation, Yura Group and Casma Group of the Mesozoic age which possibly host stratabound ore deposits
(v) Areas in which known mineral indications are situated.

As the result, the following five areas in order from west to east have been selected:

① Nazca Area
② Tocota Area
③ Chuquibamba Area
④ Andagua Area
⑤ Orcopampa Area

The extracted areas of interest are tabulated below.

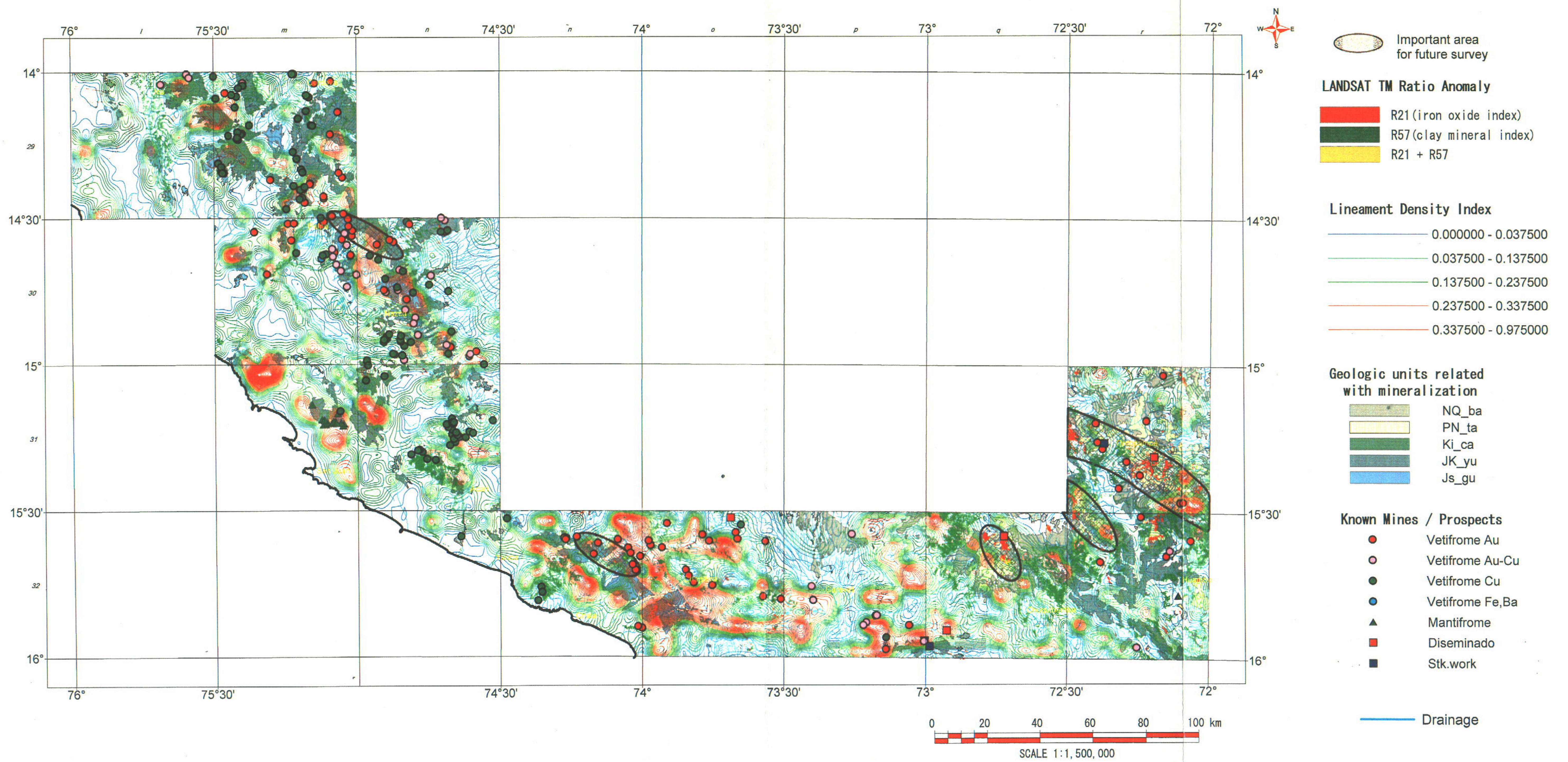

Fig.16 Integrated interpretation map

Areas of Interest

Area	Center Coordinates	R21 (Iron Oxide Index)	R57 Clay Mineral Index)	Lineament Density	Objective Country Rocks	Known Indication
①Nazca	14°25' S 75°15' W	Weak near Yura Group	Small scaled in Yura G., trends NW-SE	High density Summit	JK-yu (Yura Group)	Au Vein type
②Tocota	15°40' S 74°10' W	Small scaled within Guaneros Formation	Medium scaled along fault system in Guaneros F.	High density 3 summits	Js-gu (Guaneros F.) JK-yu (Yura Group)	Au Vein type
③Chuqui-bamba	15°40' S 72°45' W	Large scaled within Tacaza Group and continue to Barroso Group	Small scaled in Tacaza G. and Barroso G. Overlap to R21 in part	Saddle Between high density summits	PN-ta (Tacaza G.) NQ-ba (Barroso G.)	Au Dissemination type
④Andagua	15°30' S 72°25' W	Large scaled within Tacaza Group and continue to Barroso Group	Small scaled in Tacaza G. and Barroso G. Overlap to R21 in part	High density 2 summits	PN-ta (Tacaza G.) NQ-ba (Barroso G.)	nothing
⑤Orcopampa	15°20' S 72°15' W	Large scaled within Tacaza Group and continue to Barroso Group	Medium scaled in Tacaza G. and Barroso G. Overlap to R21 in part	High density 4 summits	PN-ta (Tacaza G.) NQ-ba (Barroso G.)	Au Vein type Dissemination type Stockwork type

Recommended themes of study on the respective areas of interest are summarized in the following paragraphs.

(i) Nazca area

The area is extensively underlain by the Yura Group of Mesozoic age. Both at the southern and northern sides of the area, lie large-scale intrusive rocks of the Tiabaya Super-unit while vein-type gold deposits concentrate. It is recommended to conduct reconnaissance survey to collect data concerning composition of gangue minerals of vein-type deposits of gold alone, temperatures of ore formation, alteration of country rocks which could not be extracted from the satellite images, in search of possible occurrence of blind stratabound deposits.

(ii) Tocota area

The area is extensively covered by the Guaneros Formation of Mesozoic age. At the northern side of the area, lie the Tiabaya Super-unit as well as the Bella Union Complex while vein-type gold deposits concentrate. Around the contact with the Tiabaya Super-unit near the eastern edge, a small-scale concentration of anomalies of the clay minerals index is observed, which partially overlaps spotted anomalies of the iron oxide index. It is therefore recommended to conduct reconnaissance survey to collect data concerning composition of gangue minerals, ore formation temperatures, alteration of country rocks which could not be extracted from the images, etc. in search of possible occurrence of metasomatic deposits in the eastern part of the area.

(iii) Chuquibamba area

The area is covered chiefly by the Tacaza Group of the Miocene age and also by the Barroso Group of the Pleistocene age. In the area, situated on the north slope of an elevation of lineament density, anomalies of the iron oxide index concentrate, partially overlapping anomalies of the clay minerals index. There occur dissemination-type gold deposits. It is therefore recommended to conduct reconnaissance survey for verification of the alteration of country rocks extracted from the satellite images and also for geologic data collection including rock sampling, in search of possible occurrence of epithermal gold deposits.

(iv) Andagua area

The area is covered by the Tacaza Group of Miocene age and the Barroso Group of Pleistocene age. In the area, situated at a NW-SE trending elevation of lineament density including its peak, observed is a small-scale concentration of anomalies of the iron oxide index which partially overlap spotted anomalies of the clay minerals index. Though no ore indications have been known within the area, it is recommended to conduct reconnaissance survey for verification of the alteration of country rocks extracted from the images and for geologic data collection including rock sampling, thereby comprehensively investigating composition and forming temperatures of alteration minerals, chemical analysis of rock samples, etc. in search of possible occurrence of epithermal gold deposits.

(v) Orcopampa area

The area is covered predominantly by the Tacaza Group of Miocene age and also by the Barroso Group of Pleistocene age and Recent pyroclastic rocks. In the area, a peak of lineament density is located, as well as concentration of anomalies of the iron oxide index partially overlapping spotted anomalies of the clay minerals index. An operating mine is also situated in the area. It is, therefore, recommended to conduct reconnaissance survey for verification of the alteration of country rocks extracted from the images and also for geologic data collection including rock sampling, thereby comprehensively investigating composition and formation temperature of altered minerals, chemical analysis of rock samples, etc. in search of possible occurrence of epithermal gold deposits.