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MORPHOLOGIC EVOLUTION OF GOLD GRAINS VERSUS DISTANCE TO THE SOURCE IN RECENT SEDIMENTS AT THE LAS PALMAS DISTRICT, CENTRAL CHILE: AN EXPLORATION TOOL

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INTRODUCTION

The Las Palmas gold district is located at the flanks of the Las Palmas creek, 100 km northwest of Santiago city at an elevation of 260 m above sea level, in the Coastal Range of Central Chile. Mined intermittently since Inca times, the district was famous for its placer gold ores. The source of coarse-grained gold in recent sediments at Las Palmas district is of considerable economic and geologic significance but remain poorly understood. The study about the characteristics and origin of gold grains was carried out in connection with a project dealing with precious metal exploration in the district, which conducted to the discovery of lode-type mesothermal gold mineralization. Economic potential of the orebodies remains under exploration. However, preliminar estimations indicate resources of about 1 million ounces of gold. The topography of the zone is dominated by deep weathering profiles (30-70 m), in which outcrops of rocks are very scarce, and conventional exploration geochemical methods were unsuccessful. The relief is almost flat and mature, and differences of elevation in the district do not exceed 200 m. Small creeks, active only in winter, deposit discrete sediments, consisting of middle to fine-grained sands. The morphology of gold grains evolves during transport, as a function of the distance from the source (e.g. DiLabio, 1990; Herail et al., 1989; Eyles, 1995). Considering the existence of a single relationship between the hydrothermal ore deposit, erosion, and gold grain concentration in recent sediments, an excellent oportunity for the quantification of morphologic evolution of gold particles versus distance from the source is represented.

GEOLOGY OF THE DISTRICT

The oldest rocks consist of a metapelitic sequence of the upper Paleozoic, which exhibit amphibolitic metamorphic assemblage. This sequence is intruded by plutonic rocks consisting of upper Jurassic (162-160 Ma) biotite and amphibol tonalites with discrete bodies of amphibolitic gabbros. Quartz and muscovite-rich granitoid dikes are the youngest rocks in the district (157 Ma), constituting the host rock of the hydrothermal gold mineralization (Hurtado, 1999). They trend N40°-60°E, generally dip steeply, are 0.1 to 10 m wide, and exhibit kms in strike length. These felsic rocks are fine to coarse grained and consist of quartz, muscovite, albite, K-feldespar, and minor sphene and Fe oxide. The quartz and muscovite-rich granitoid dikes normally conform swarms of 30 to 50 m wide, in which 20 to 35% of the rock volume corresponds to the felsic rocks. The most remarkable structural feature in the district are N50°-70°W and N40°-60°E trending faults, in which both systems consist of steeply deeping structures. The NE trending faults cross cut the NW oriented structures, controlled the emplacement of the felsic dykes and commonly created open spaces, which were filled by quartz veins.

The area is dominated by deep wathering profile, in which the depth of the oxidized zone varies from 30 to 70 m. Recently, due to forest fires, the weathering profile has been in part further eroded by rainwash. The products washed away by the erosion accumulate at the foot of the slopes, while on the unforested reliefs only the lower horizons of the wathering profile remain, consisting of powdery micaceous soil and vertical fissures filled by red clay (mainly kaolinite and limonite). Beneath this saprolitic soil, the intrusive rocks remain intensively weathered to the limit of the oxidation zone, normally located between 20 to 25 m depth.

MINERALIZATION

The ore deposits consist of swarms of mineralized felsic dikes and veins, constituting ore bodies of 10 to 40 m thick and 200 to 250 m long, oriented N40°-50°E. Mineralized felsic dikes and veins are 0.1 to 3 m wide, dip steeply and represent between 20 and 25% in the rock volume of the ore body. The host rock corresponds to upper Jurassic tonalites. Normally the veins occur in the contact between the tonalitic plutonic rocks and felsic dikes, following the NE-strinking faults. Hydrothermal alteration and gold mineralization developed in two stages. The early stage consists of dissemination in the felsic dikes and brecciated veins, in which the mineralogical assemblage is quartz, hematite, magnetite, pyrite, native gold, muscovite, and tourmaline. The late stage occurs as network of veinlets that cross cut the mineralized felsic dykes and veins, and in lesser extent the tonalitic host rock. It is characterized by quartz, hematite, magnetite, jasper and gold. The precious metal is present in both hydrothermal stages mainly as free gold, in intergrowth relationship with quartz, muscovite, Fe oxides and pyrite. Traces of fine-grained gold has been observed as blebs within magnetite crystals. The size of gold grains varies between 0.05-5.3 mm. Ore grade in the mineralized felsic dikes and veins range from 10 to 35 ppm Au and the average of gold concentration in the ore bodies is of about 3 to 5 ppm.

Radiometric dating of hydrothermal muscovite indicates an age of 151 Ma. Fluid inclusion studies in hydrothermal quartz indicate homogenization temperatures ranging from 260° to 338°C, and apparent salinities varying between 8.7 and 17.5% NaCl equivalent, without evidences of boiling (Hurtado, 1999).

RESULTS

Samples were collected from active sediments using hand wash concentrator. Sixty samples were treated, from which 1,502 gold grains have been extracted and studied (0.01-5.3 mm). The grains were measured and their morphology described under optical microscope and SEM. The results of this study is summarized in the Table 1. No recrystallization forms in gold particles has been found. On the basis of morphological characteristics, three different groups of gold particles have been recognized.

The first corresponds to the gold grains recovered between the orebody and 50 m downstream. In this track, the particles maintain their general shape occurring in the orebody: square to rectangular, angular and partially with bays. The outline of the grains are irregular, showing also surfaces with irregular topography. Normally the gold particles exhibit primary crystal imprints and present inclusions of quartz and Fe oxides. The flatness index (defined by the relation (L+b) /2t, where L is length, b the breadth and t the thickness) of the grains varies between 1 and 3.6.

The second group corresponds to the gold particles recovered in recent sediments between 50 and 300 m away from the source. In this distance range the grains exhibit triangular to fairly elongated and weakly angular shapes. The outlines are fairly regular, with some evidences of folding. The surface consists of irregular topography and the grains present any cavities. Primary crystal imprints are diffuse and associated minerals consist only of few Fe oxide crystals. The flatness index ranges between 2.1 and 6.0.

The third group corresponds to the gold grains recovered in recent sediments over 300 m away from the source. The gold particles are rounded to oval, with any elongated exemplars. The outline is very regular, and the surface exhibits a regular topography. Impact and groove marks are common. Primary crystal imprints are absent and associated minerals consists only of limonite and clay coatings. The flatness index varies between 3.0 and 7.5.

Statistical studies indicate that measurement of 20 gold particles in each distance range are sufficient in order to obtain an estimation of distance between the samples and the gold-bearing orebody.

CONCLUSIONS

The contribution of this paper is to document the morphologic evolution of the gold particles versus distance to source in the Las Palmas district. We have attempted to model parameters such as general shape, outlines, surface, primary crystal imprints, associated minerals and flatness index in order to be used as an exploration tool. This morphologic evolution form a progression from relatively undamaged grains between the orebody and 50 m downstream, to ones located in the active sediments over 300 m away from the source that retain none of their original features. The proposal classification is meant to be simple and graphic -to aid in describing gold particles, which should assist drift prospecting.

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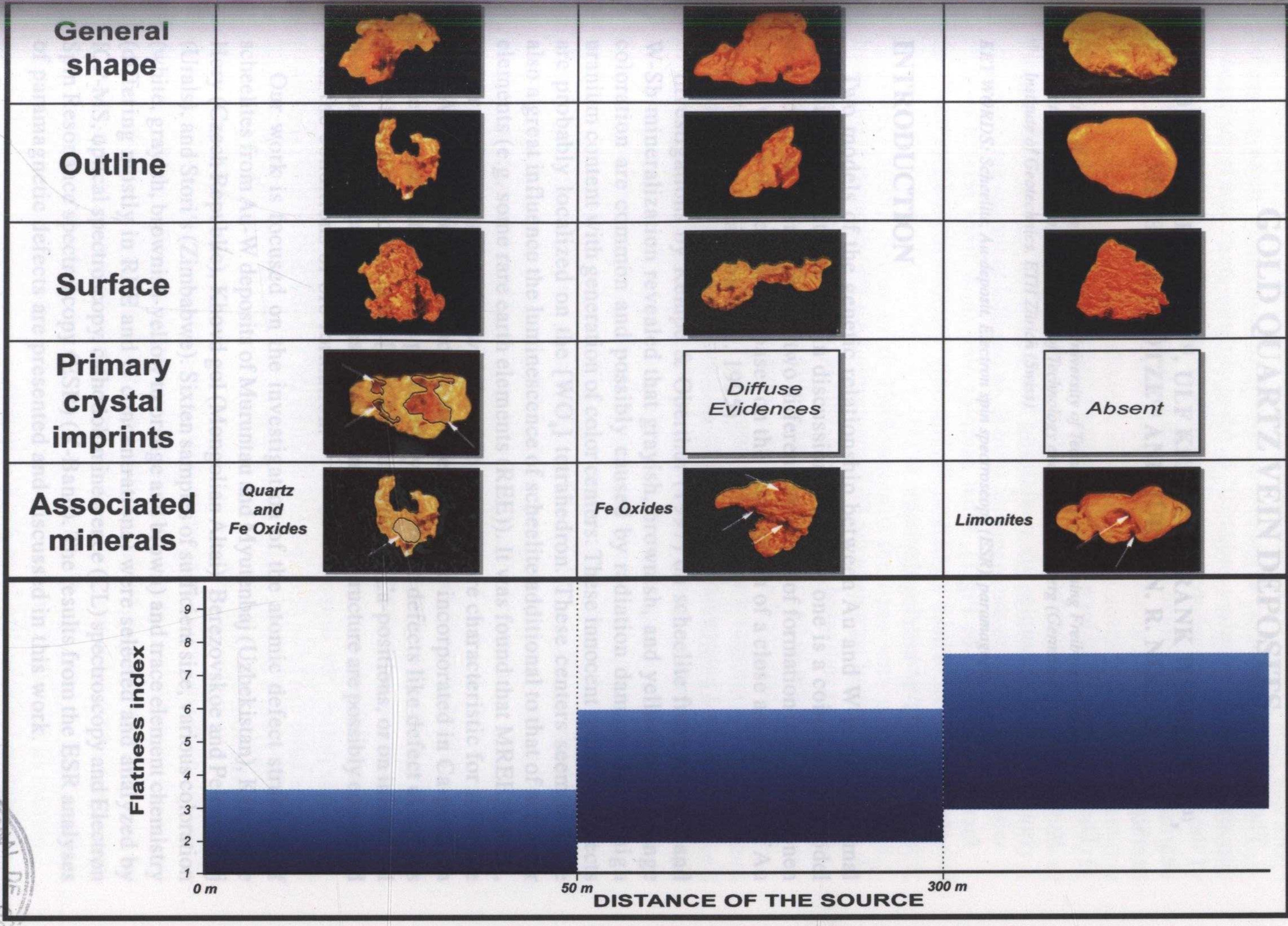
General shape
Outline
Surface
Primary crystal imprints
Diffuse Evidences
Absent
Associated minerals
Quartz and Fe Oxides
Fe Oxides
Limonites
Flatness index
9
8
7
6
5
4
3
2
1
0 m
50 m
300 m
DISTANCE OF THE SOURCE

CONCLUSIONS

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