The Marcona Copper Project – Mina Justa Prospect Geology and Mineralisation

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Introduction

The Mina Justa Copper Prospect is the largest new discovery of an Iron Oxide Copper Gold ("IOCG") deposit in Latin America in the last 10 years and is located near the deep water ports of San Nicolas and San Juan de Marcona in Southern Peru. Chariot Resources Limited (70%) and their partners LS-Nikko Copper Inc. and Korea Resources Corporation (30%) are in a joint venture (Marcobre J.V.) and are currently drilling part of the known Rio Tinto Global Resource of 627MT @ 0.59% Cu[8] and testing a number of exploration targets close to this resource. This paper briefly describes the district and local geology, alteration and mineralogy and also discusses early stage drilling success on the exploration program[7].

Location

The Project is located within the Ica Department of the southern Peruvian coastal belt and approximately 400 km southeast of Lima. The center of the Project lies approximately 25 km north of the coastal town of San Juan de Marcona. The town of Nazca, on the Pan American highway, is located approximately 35 km to the north-northeast. Access to the Project is by driving approximately 6 to 7 hours south from the city of Lima along the Pan American highway.

Project elevations range from 500 masl to nearly 1200 masl and the geographic co-ordinates of the center of the Project are approximately 15°08'S and

75°04'W. The Mina Justa Prospect is the principal exploration target on the Project and occurs at elevations ranging from 785 masl to 810 masl.

The Project consists of two adjacent and contiguous areas referred to as Target Area 1 (Block TA1) and the "Marcobre Claims" , which together cover 32,899.31 ha[8] (see Fig 1.) and occur adjacent to the north and east of the Marcona Iron Mine property (Shougang).

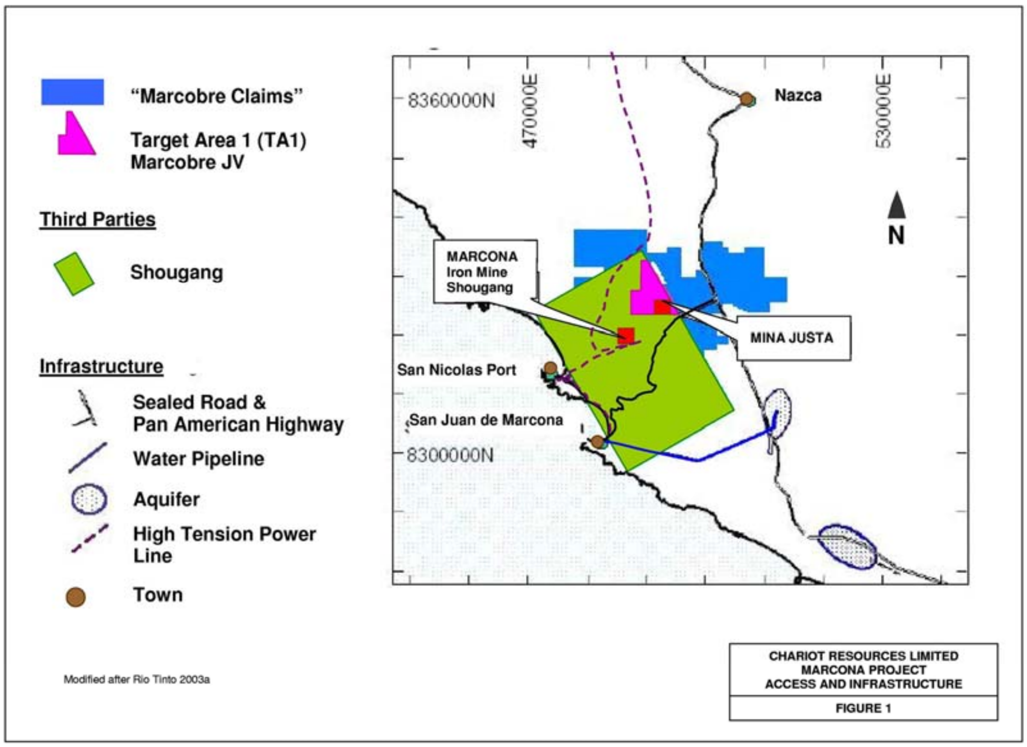

Fig. 1 Marcona Project Access and Infrastructure

History

The exploration history and mining on the Project, and particularly on the Mina Justa Prospect, started in the 1950's and has continued since then by four separate companies. The most detailed work has been done by Rio Tinto between 1993 and 2003, and consisted of regional airborne magnetic and radiometric surveys, geological mapping, geochemistry, geophysics and drilling.

Extensive drilling, limited metallurgical testing, and resource estimations were completed on the Mina Justa Prospect.

During the period of 2001 to 2003, the Mina Justa Prospect was explored by Rio Tinto with 103 holes totalling 30,971.55 m. This includes 11 core holes totalling 3,700.00 m, 76 reverse circulation (RC) holes totalling 19,428 m, and 16 combination RC and core holes totalling 7,843.55 m (4,140 m RC and 3,703.55 m core)[4]. The drill hole spacing at Mina Justa prior to Chariot's current program is on the order of 300 m by 150 m with the occasional additional hole reducing the spacing to 75 m to 100 m[1].

The total (oxide, mixed and sulphide) Inferred Mineral Resources as estimated by Barnes from AMEC in November 2004 are 218.3 Mt grading 0.8% CuT, at a cutoff of 0.2% CuT[8]. These resource occur within a much larger area of "upside potential", as defined by Rio Tinto in 2003. The estimated (oxide plus mixed plus sulphide) mineralization within the "upside potential" is 640 Mt grading 0.6% CuT at a 0.2% Cu cutoff[3] and according to NI 43-101 would equate to a possible mineral deposit that is the target of further exploration.

Near the end of 2003, Rio Tinto concluded that the Mina Justa Prospect failed to meet the company's minimum size requirement and placed its interest in the Project for sale[6]. Chariot Resources Limited together with their Korean Joint Venture Partners closed the purchase of the Project in January 2005.

Geological Setting and Structural Geology

The Marcona Project consists of five Fe-oxide Cu (Ag-Au) prospects that are part of the large iron-oxide rich hydrothermal system associated with the Marcona Fe (+/- Cu, Au, Ag, Zn, Co) deposits located within a few kilometres immediately to the south and west[1]. These are currently being mined by Shougang at the rate of approximately 4.5 to 5.0 Mt/annum.

Copper mineralised prospects within Chariot's project area are distributed marginal to, or within the regional, northwest trending Marcona Graben, which is developed within mid to Late Jurassic rocks and Paleozoic rocks. Three prospects including Mina Justa occur along a 15 km stretch of structural zones defining the western margin of the graben. Several intra and post mineral hypabyssal intrusives and dykes, including "ocoite" dyke swarms can occur within or in close proximity to the copper mineralization.

The most potentially economically significant copper mineralization is on the Mina Justa Prospect, where based on widely spaced drill holes, an overall shallowly dipping fault zone has been interpreted by Rio Tinto geologists to control patches, veinlets and breccia fillings of copper-bearing sulphides accompanied by varying amounts of magnetite and actinolite. This drilling has identified two principal copper mineralized zones, which are associated with several subparallel, northeast trending, nearly flat to very shallowly southeast dipping structural zones (see Fig 2).

i. **Main Zone:** This zone occurs on surface as a northeast trending, 400 m long series of shallow pits and diggings, which are part of a "basal" mineralized structure. This structure dips at 10˚ to 30˚ to the southeast and has been intersected along its dip by 36 drill holes over a 1,700 m distance, to a maximum depth of 500 m, where it remains open.

ii. **Upper Zone:** On surface, this zone outcrops subparallel to, and approximately 400 m southeast of the Main Zone. It has a similar elongate to oval shape and also dips at 10˚ to 30˚ to the southeast. On surface this zone has been identified through a series of about 15 pits and shafts (to a maximum depth of about 80 m) over an approximate 300 m distance. This zone has been intersected by 19 drill holes over its 1,100 m down-dip extension to a maximum depth of 250 m.

Both the Main and Upper Zones are between 10 m and 200 m thick, and are thickest closest to interpreted steep southwest dipping splays[3]. The separation between the two zones generally ranges between 100 m and to 200 m.

The geometry of the Main and Upper Zones is similar. Both structures appear to be curved, listric feature that has an overall east-southeast to southeast dip. The thickness of the Main Zone increases from west to east towards the base of the listric fault. However, in its eastern portion, the Main Zone has been interpreted to dip very shallowly west-southwest to southwest.

Generally, in the Mina Justa prospect the upper 200 m of all zones is characterized by copper oxide mineralization, with sulphides gradually becoming dominant at lower levels. The sulphide assemblages have been reported to be concentrically zoned outward from low to higher sulphidation assemblages: bornite-chalcocite in the core through intermediate bornite, chalcopyrite and pyrite zones to peripheral pyrite. The dominant copper oxide minerals are chrysocolla and atacamite, minor almagre, neotocite and rare tenorite and cuprite[3]. Barren or near-barren ocoite dykes have been estimated to occupy volumes to 15% to 35% by volume within the mineralized zones.

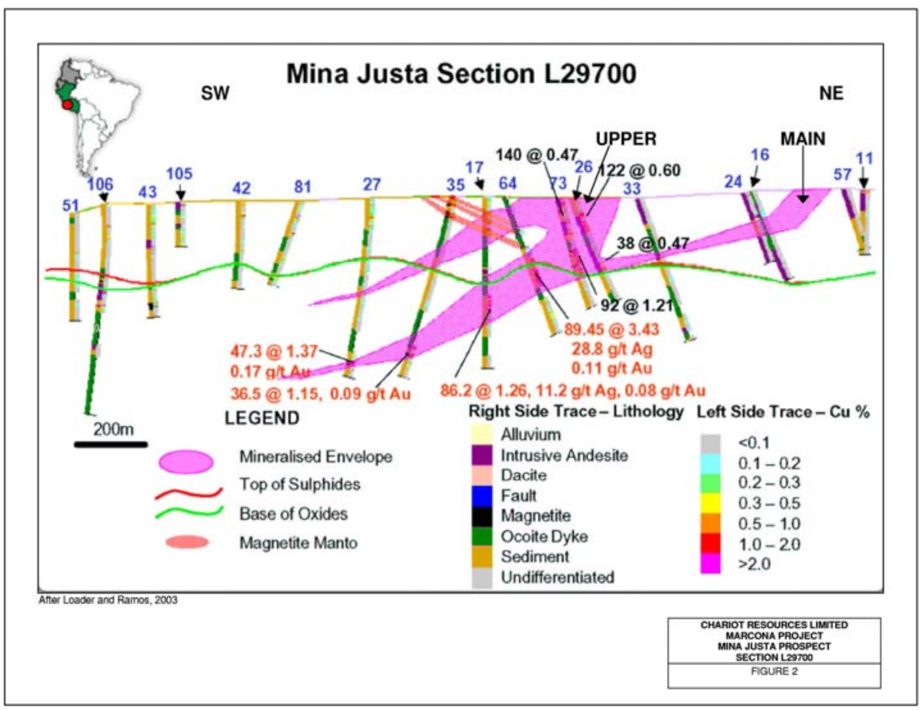

Fig. 2 Long Section through the Main and Upper Zones of Mina Justa

Regional & District Geology

The Marcona Fe-oxide Cu (Ag, Au) Project is located near the southern end of a belt approximately 70 km wide and stretching 400 km along the Peruvian coast from Lima to south of Chala. This belt hosts numerous mineral occurrences grouped together under the general heading of iron-oxide copper-gold (IOCG) deposits[2]. The belt consists of a series of Precambrian gneisses and schists overlain by subordinate Palaeozoic sediments and volcanics and by more extensive volcano-sedimentary rocks of Triassic-Jurassic age. Numerous dykes and stocks ranging from felsic to mafic composition intrude the belt. Tertiary ignimbrites and Quaternary aeolian deposits cover a large part of the belt[2].

The Marcona Fe-oxide Cu District straddles the intersection of the northeast trending Nazca Ridge and the continental margin, coinciding with the southern limit of the major Peruvian flat-slab domain and the northern limit of the Central Volcanic Zone[2].

The stratigraphy for the Marcona Fe-oxide Cu district is summarized in Figure 3.

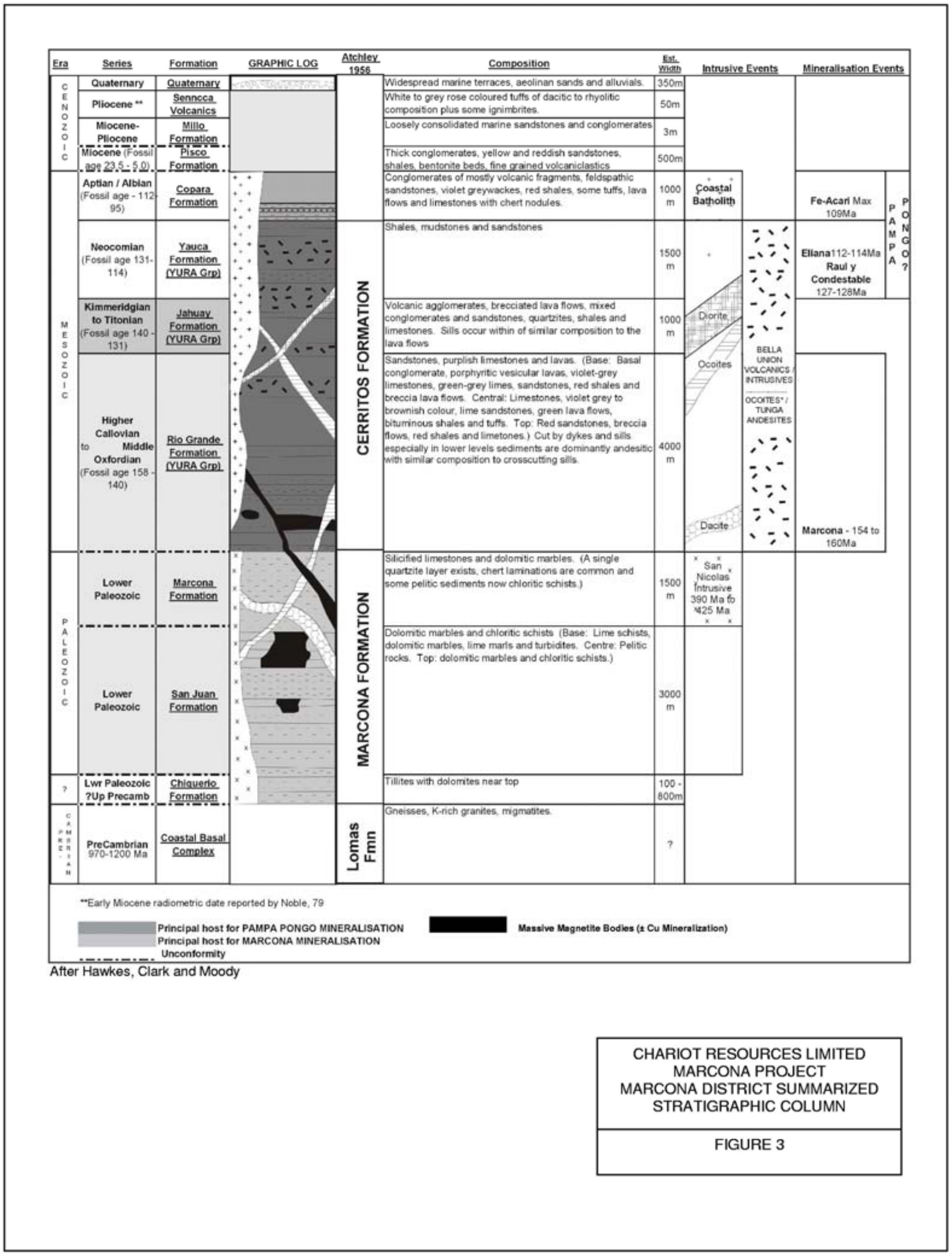

Fig 3. Marcona District Summarized Stratigraphic Column

Local Geology

Basement rocks in the district consist of a Precambrian gneiss complex, commonly known as the Lomas Formation. The gneisses are unconformably overlain by Palaeozoic dolomites, limestones and sediments, and a thick sequence of Jurassic and Cretaceous volcanic sediments.

The Palaeozoic rocks have been subdivided into the San Juan Formation and the overlying Marcona Formation, with the upper unit distinguished from the lower unit by the presence of a quartzite layer and thin chert laminations within the carbonates. The Marcona Formation predates (425 +/- 4Ma) the San Nicholas Batholith that intrudes it along the western margin of the district[6]. The Marcona Formation has been metamorphosed to low to mid greenschist facies chlorite schists, phyllites, and dolomitic marbles[5].

The mid to late Jurassic sequence has been subdivided into the Rio Grande, Jahuay and Yauca Formations. The Rio Grande Formation and the overlying Jahuay Formation are composed mostly of andesitic volcanics, sediments and limestones. The Yauca Formation is largely comprised of fine grained sediments and subordinate sandstone[2]. The lower part of the Rio Grande Formation is of dominantly andesitic composition[5] and has been metamorphosed to greenschist facies. The Jurassic sequence is unconformably overlain by the Miocene Pisco Formation in the east, and by Quaternary marine terraces in the west[5].

A wide range of intrusive rocks have been mapped in the Marcona District. The San Nicholas Batholith intrudes the basement gneiss complex and the Palaeozoic sediments, but pre-dates the Jurassic sequence. Compositional variations within the batholith include monzogranite in the center passing outwards to granodiorite and diorite[2].

In addition, several intra- and post mineral hypabyssal intrusives and dykes occur in close proximity to the Marcona Iron Oxide mineralization. Late stage andesitic porphyry (ocoite) dykes cut the iron mineralization in the Marcona mine area and the copper mineralization in the Mina Justa Prospect. Dykes, stocks and plutons of the Tunga andesites also intrude the Marcona, Rio Grande and Jahuay Formations.

As shown in Figure 3, the iron and copper mineralization in the Marcona District is hosted by the Marcona and the Rio Grande Formations[6]. Both formations strike northeast and dip homoclinally to the northwest at 45° to 65°. Sillitoe (2003) noted that, notwithstanding the lack of an angular discordance that can be mapped between the Marcona and the Rio Grande Formations, an appreciable age separation is supported by a conglomerate at the base of the latter as observed in drill core[6].

Dolomite horizons in the Marcona Formation and limestone horizons in the Rio Grande Formation appear to be the preferred host rocks for the magnetite deposits, whereas andesitic volcaniclastic rocks and a sill-like, sub-volcanic porphyritic andesite intrusion in the Rio Grande Formation contain the Mina Justa copper mineralization[6].

The geology of the Mine Justa Prospect is shown in Figure 4. The Mina Justa Prospect copper mineralization is hosted by volcano-sedimentary rocks of the Rio Grande Formation that is dominated by andesite volcaniclastic units and sill-like, sub-volcanic porphyritic andesite intrusions[3, 1].

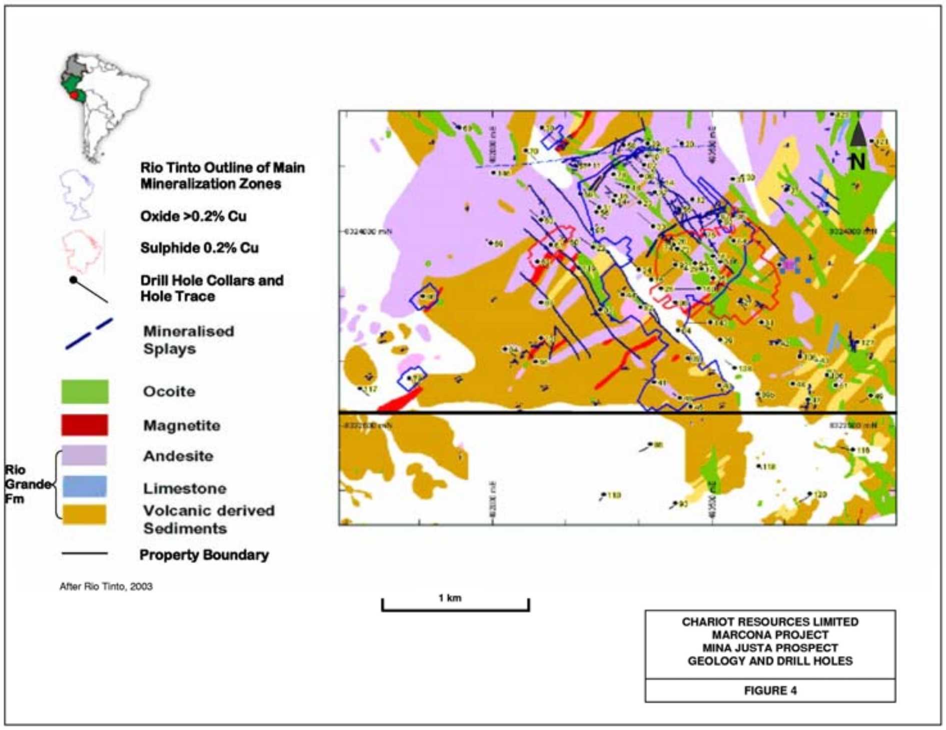

Fig 4. Mina Justa Prospect Geology and Drillholes

The volcaniclastics consist of crystal tuffs, epiclastic sandstones and siltstones, medium to coarse lithic volcaniclastic rocks of andesitic composition, and fine-grained andesites with minor lenses of fossiliferous limestone. Bedding, as measured from the sandstones, dips consistently 40 - 60° to the northwest. There are some disruptions to the bedding to the east of the prospect, where it swings to a more northerly strike[3]. Limestone and coarser volcaniclastic beds are inferred to be lenses within a laterally continuous, layered sequence. The volcaniclastics are intruded by pre-mineral, sub-volcanic hornblende-plagioclase porphyritic andesite. The andesite intrusions are sub-horizontal with irregular contacts. The area is intruded by northwest-trending, late ocoite dykes that are 20 m to 50 m wide and dip consistently 60° to 70° to the northeast[3]. In the eastern and western parts of the Mina Justa Prospect area, the ocoite dykes appear to have a more stock-like form. The composition of the ocoite dykes and intrusive andesites are similar and if the andesite is coarsely porphyritic they are difficult to distinguish. Phenocrysts tend to be altered (cloudy) in the intrusive andesite, while ocoite phenocrysts are rarely altered (see Photo 5, Appendix A). The similarity between the early intrusive and late to post mineral ocoite dykes suggest a single long-lived magma source related to the mineralization[3].

Pre or syn-mineral dacite and diorite dykes are common at the Marcona Iron Mine and occur in minor amounts at Mina Justa.

Alteration and Mineralisation

The outer limits of the Marcona District may be defined by the transition from the magnetite replacement mantos to unreplaced, albeit marbleized dolomite or limestone[6].

Three main alteration assemblages are recognized at the Mina Justa Prospect[6]:

- K-feldspar: K-feldspar±albite-specularite-chlorite-calcite; as pervasive replacement and minor veinlets.
- Actinolite: actinolite±magnetite-apatite; as replacement and coarse actinolite±apatite vein fill,
- Magnetite: semi-massive to massive fine-grained magnetite as replacement.

Magnetite alteration is the host to manto-type copper mineralization. Magnetite replaces reactive limestone and carbonate-rich beds in the stratigraphic sequence to form stratiform mantos. The magnetite in manto form is an early event and pre-dates the main copper event. Epidote and calcite veins overprint the previous alteration assemblages[6].

No clear zoning of alteration assemblages is recognized. Mineralogical mapping at surface shows a concentration of actinolite to the southwest and quartz-specularite to the northeast. A deeper core of potassic alteration is also inferred. Mineralization is spatially associated with stronger actinolite and magnetite alteration[6].

Local Structure

The dominant fault attitudes as determined from drill holes and surface mapping are:

- northeast trending, shallow (10°-30°) to steep (70°) east-southeast to southeast dipping faults, belonging to the "Repetition Fault System".
- northwest trending, steeply northeast dipping normal faults, belonging to the "Huaca Fault System".

Iron and copper mineralization at Mina Justa is strongly controlled by the Repetition Fault System.

As shown in Figure 5, the structural model envisioned for the mineralizing system is a shallowly east-southeast to southeast dipping fault system with steeper dipping splays in section. Splays also horsetail in plan view to create a large volume of fractured rock with an overall dip parallel to the main flat structures, i.e. approximately 20° with "bulges" around the junctions with the splays[3].

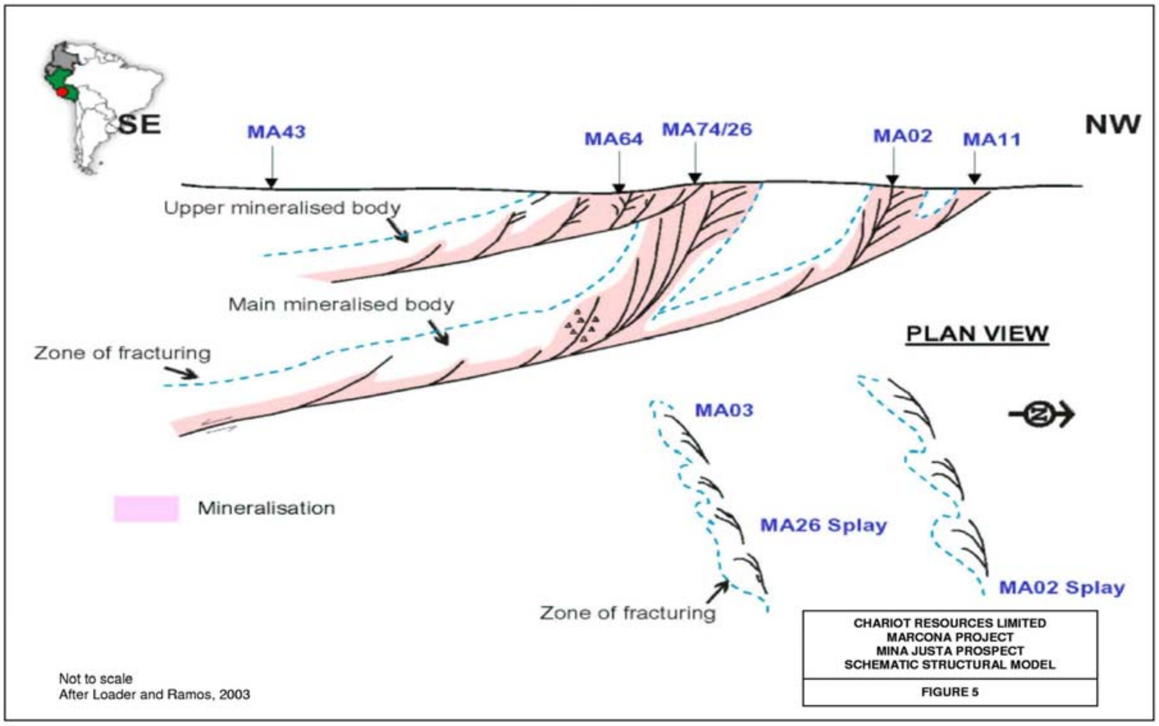

Fig. 5 Mina Justa Prospect Schematic Structural Model

The Huaca Fault System forms prominent northwest-southeast scarps that have displacements of up to 400 m down dropped to the east. Local offset at the Mina Justa Prospect is estimated to be in the order of tens of meters or less. There is commonly a lateral movement also associated with these faults although this appears to be variable[3]. The ocoite dykes at the Mina Justa Prospect have intruded along the structures of the Huaca Fault System.

Hypogene Mineralisation

Two types of copper mineralization are recognized at the Mina Justa Prospect:

- structurally-controlled copper as disseminations and blebs, veinlets, vein and breccia-filling.
- copper hosted by stratabound iron-oxide mantos[3].

The structurally controlled copper mineralization is the dominant type at the Mina Justa Prospect. Copper mineralization is hosted in at least three mineralized fractured and faulted structural zones that trend northeast and dip approximately 20° to the southeast[3].

The associations and styles of copper mineralization are summarized in Table 1.

Table-1

Styles and Associations of Copper Mineralization at Mina Justa Prospect

Mineralization Type	Association and styles			
Copper-sulphides: chalcocite, bornite, chalcopyrite, pyrite	+Magnetite ± actinolite breccia fill	Replacing semi-massive to massive magnetite “mantos”	+magnetite ±actinolite ±apatite in veins and veinlets	Disseminated – blebs and fine in varied alteration assemblages (K-spar, actinolite-magnetite-sphene)
Copper-oxides: Chrysocolla / Atacamite	Fracture fill	Disseminated		

Sillitoe (2003) described concentrically zoned sulphide assemblages which varied outwards from low to higher sulphidation assemblages: bornite-chalcocite in the core through intermediate bornite, chalcopyrite and pyrite zones to peripheral pyrite. This zoned sequence of sulphide assemblages is believed by Sillitoe to define the fault conduit via which the mineralizing fluid was channelled upwards[6].

Copper grade is generally proportional to the amount of copper sulphides, which in turn is proportional to the amount of magnetite, supporting sulphidation of magnetite as an important depositional mechanism for sulphides[1].

Reverse Circulation drilling undertaken by Chariot in March-April 2005 at the Marcona Copper Project reported very high grade copper intercepts in the initial round of drilling. These high grade zones contribute significantly to the in ground metal content of the prospect. Chariot reported intersections such as 116 metres @ 2.55% Cu, including 26 metres @ 5.79% Cu[7] (in sulphides) between depths of 214 m and 330 m. These results indicate a very robust predominantly sulphide style mineralization, which at the time of writing was still open in three directions.

Oxide Mineralisation

Copper mineralization at the Mina Justa Prospect has been oxidized to an average depth of approximately 200 m, though the depth is variable and can extend to 300 m. Dominant copper oxide minerals are chrysocolla and atacamite along with minor almagre, rare tenorite and cuprite and occur mostly as fracture fillings and disseminations[4]. Approximately 50% of the copper resource as defined to date by Rio Tinto, is oxidized[3].

Conclusions

The Marcona Copper Project hosts the Mina Justa Prospect which is the most important IOCG prospect discovered to date in the coastal belt of Peru. Chariot and its partners are planning to take the project through to completion of a feasibility study by the end of 2006. It is likely that increased understanding of Mina Justa and surrounding prospects through geological research and exploration activity will result in an increase of tonnage and grade of the project.

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