Discovery of the Ujina Cu deposit, Collahuasi District, Chile

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Summary

The Collahuasi District of Chile, situated high in the Andean *antiplano*, approximately 4300m ASL, is a historic mining district. In 1990 the Collahuasi joint-venture (Falconbridge, Chevron, Shell), refocused its exploration efforts from exploring a small high-grade vein resource in the Rosario porphyry area to a more regional evaluation for primary and secondary Cu mineralization. As part of this process, an IP test survey, carried out on the property in 1979, was uncovered and recompiled. The new interpretation indicated that, unlike elsewhere in Chile, conductive cover and poor ground conditions were not problematic. Also, IP and resistivity response from this survey to known ore was clear-cut and suggested that IP was ideally suited to the terrain and the target. The ensuing 200 km IP/resistivity program not only defined the Rosario/La Grande porphyry system (710 mT @ 0.93% Cu) in its entirety, but also led to the discovery of a totally new resource, the Ujina deposit (1200 mT @ 0.8% Cu, including 126 mT of secondary enrichment), under 170 meters of ignimbrite cover.

Introduction

The Collahuasi mining district is situated in Northern Chile, close to the Bolivian border, 200 kilometers south east of the port of Iquique. Currently the district hosts three major copper porphyry deposits, Quebrada Blanca, Rosario, and Ujina . This paper will focus on the discovery of the Ujina deposit, which is covered by 170m of Quaternary ignimbrite. In 1990, the Collahuasi Joint Venture consisting of Falconbridge, Chevron, and Shell was at a critical juncture. A large but relatively deep Cu resource had been established in the Rosario area, but all partners acknowledged that without a shallower higher grade resource to boost the economics of the project, it was unlikely to go into production any time soon. It was in this spirit that a group of determined explorationists embarked on what turned out to be exhilarating exploration program over the ensuing two years.

Exploration History

Copper has been mined in the Collahuasi district since the time of the Incas. In the early-1900's the first production was recorded as coming from the Poderosa high-grade massive sulphide vein system (average 25% Cu) , which was subsequently found to border the Rosario porphyry (See Fig.2). During this time these high-grade veins contributed a quarter of the Chile's annual copper production. By 1920 the easily-accessible vein ore was exhausted, and mining and exploration of the district stopped until the 1970's. It was at this point that the Chilean government made a concerted effort to revitalize their ailing mining industry, and Falconbridge became involved in exploring the Collahuasi district though a Joint Venture with Superior Oil, who owned a controlling interest in Falconbridge at the time. Initially, exploration was focused on the Quebreda Blanca deposit. By 1979 a resource of 144mT of copper had been defined at Quebrada Blanca, insufficient to justify going into production. It was at this point that attention was turned to the high-grade massive sulphide vein systems at Poderosa and La Grande (Figure 2). Detailed surface mapping in the Poderosa area revealed alteration typical of a copper porphyry system. Also, at the same time a second large zone of alteration was noted in the Ujina area, six kilometers east of the Poderosa mine. An intensive drill campaign was mounted in the Poderosa area, and soon a large resource of both secondary and primary ore was indicated, but again insufficient to warrant a production decision. A few exploratory holes were drilled in the Ujina area, much of which is covered by a thick layer of ignimbrite, but only disseminated pyrite was intersected.

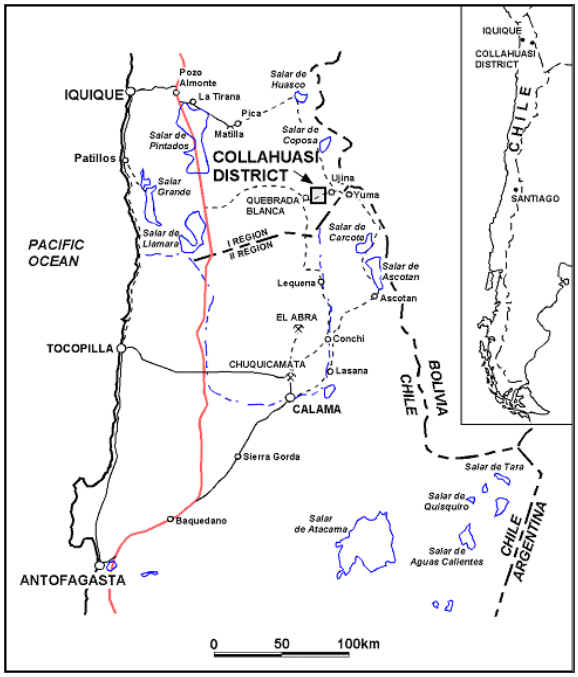

Figure 1 Location of Collahuasi Mining District

The first ground geophysics was carried out in the area in the 60's by Anaconda, when a limited amount of IP was conducted on the Quebrada Blanca property. In 1979 a modest IP program was conducted over the Poderosa Vein and the newly discovered Rosario porphyry system. The survey parameters were normal for the time, i.e. a=100 meters, n=1->4, and the data was presented in standard psuedosection format. In the early-1980's however the worldwide recession caused the burgeoning and highly successful exploration program to come to a halt. In 1984, Shell and Chevron were brought in as joint venture partners on what was henceforth to be known as the Collahuasi Joint Venture. These two companies were to spend $45 millon over an 8-year period to earn a third interest each in the project, and would be operators of the project until they had earned-in. From 1985 to 1990, Shell and Chevron focused on advancing the development of the high-grade vein system in the Rosario/Poderosa area. This work only served to prove the lack of continuity of the vein system (Moore et al, 2002). In the meantime, no regional reconnaissance work had been carried out on the property for ten years. In 1990 a new approach was deemed necessary by the JV partners, and an Exploration Task Force (ETF) was setup to direct this work.

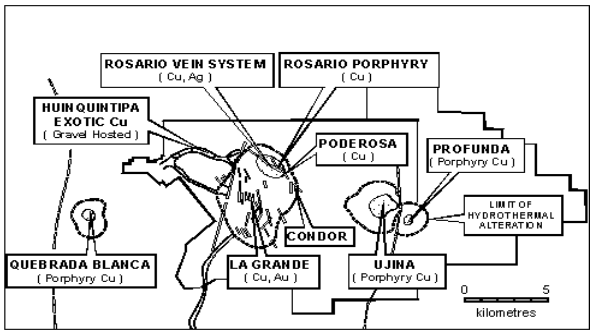

Figure 2 Map of major Collahuasi ore deposits – present day

The Ujina Discovery

In 1989, prior to the ETF formation, the 1979 IP survey came to light in an historical data review by Falconbridge exploration staff. The data was digitized, compiled into plan form, and correlated to known geology and mineralization (Figure 3).

The re-evaluation of the 1979 IP data showed an obvious near-surface arcuate response in the vicinity of the known Rosario and Poderosa mineralization, but more importantly, the apparent background IP response increased with n spacing to the SW of the known mineralization, and resistivities showed a corresponding decrease, and these responses were wide-open in that direction.

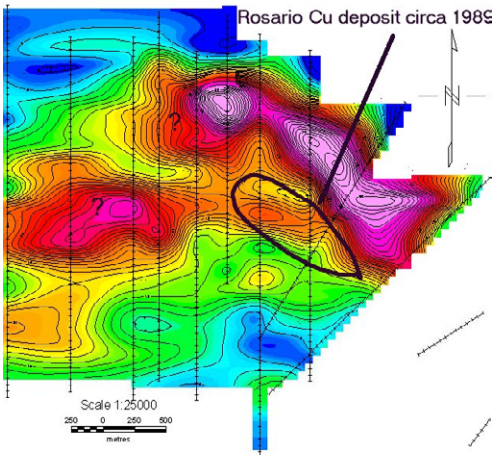

Figure 3: IP Plan Map (n=3) of 1979 Rosario test survey

It was clear at this juncture that a new deeper-penetrating IP survey would provide a valuable overview of the regional potential of the project. A new survey was designed by Falconbridge and Chevron (C.Swift) geophysical staff. The survey specifications were geared toward maximum depth penetration and rapid regional coverage, while still providing the vertical resolution necessary for reliable, quantitative interpretation. The dipole-dipole configuration was chosen, with a dipole spacing of 300 meters, reading n=1 to 6, and a minimum line separation of 1 kilometer. Quantec Geofisica was awarded the 200 kilometer survey contract, which required using their 30kW Zonge transmiter and Zonge GDP-16 IP receiver.

The intent of the survey was threefold: 1) to determine the the extent of the Rosario porphyry mineralization, 2) cover the area of the La Grande hydrothermal veins and assess whether there was any linkage with Rosario, and 3) evaluate the potential of the Ujina area by covering the mapped alteration zone discovered in the 70's. It should be noted that the initial survey design covered the Ujina alteration zone only, and stopped short of the thick ignimbrite layer immediately to the east.

The survey commenced in January, 1991 under the direction of a new Chief Geologist, Larry Dick of Chevron. In short order the survey outlined a 25 km^2 circular-shaped high-IP(Figure 4), low-resistivity (Figure 5) anomaly which encompassed both the Poderosa/Rosario and La Grande mineralized systems, and which subsequently came to be known as the "Collahuasi" anomaly. The most intriguing feature of this anomaly was the very low resistivities observed in the vicinity of the historic La Grande Au veins.

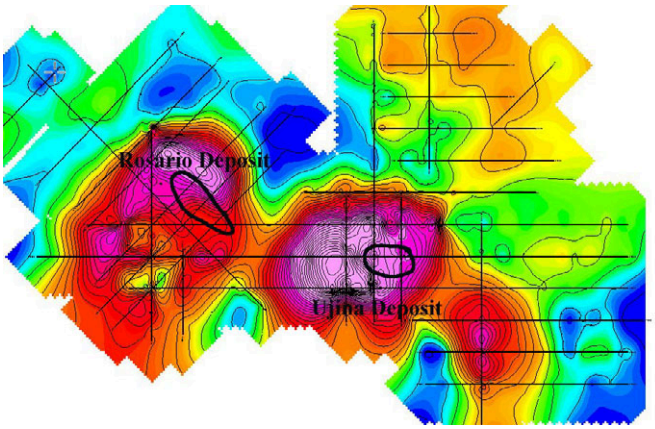

Figure 4: Plan Map of 1990 IP survey, a-300m, n=2

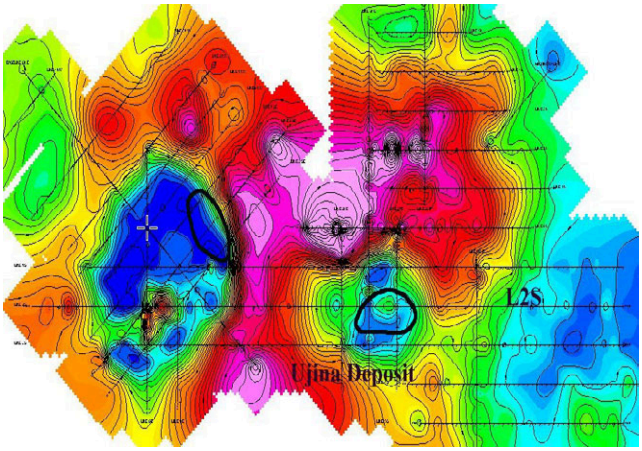

Figure 5: Plan Map of 1990 resistivity survey, a=300m, n=2

However, the most intense IP response from this initial coverage occurred directly over the Ujina alteration zone. More importantly, the response was open to the east, in the direction of the Tertiary ignimbrite cover. With little argument from anyone, the survey was extended another 5 kilometers to the east of the Ujina alteration zone. Once the necessary additional coverage was obtained, another oval-shaped IP anomaly of dimensions slightly smaller than the Collahuasi anomaly had been outlined. On closer examination the Ujina anomaly exhibited distinctly different characteristics to that of the Collahuasi anomaly. The intrinsic IP response obtained over Ujina is more intense, but at the same time the low resistivity core of the Ujina system is not as dramatic as over parts of the Collahuasi anomaly, and is shifted east of the strongest IP response at Ujina and is completely covered by ignimbrite.

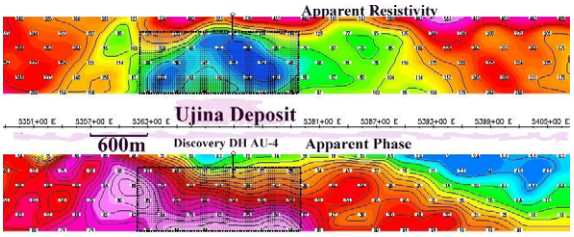

Figure 6: IP and resistivity psuedosection, L2S across Ujina Deposit and Discovery Hole, AU-4.

While the IP survey was being carried out, an enthusiastic drill crew was "hot on its heels". No sooner had the initial encouraging IP response over the Ujina alteration zone been obtained than several percussion holes were drilled to test this exciting new target. All that was intersected in this drill campaign was barren pyrite. It was soon realized that the strong IP response over the Ujina alteration zone was probably caused by a near-surface pyritic halo surrounding a new porphyry system.

Once the additional survey coverage to the east was obtained and analyzed, it was decided to test the core of a low resistivity anomaly approximately 1 kilometer east of the peak of the Ujina IP anomaly. First word back from the field was that the hole drilled to test the low resistivity anomaly, AU-4, was barren – no indication even of pyrite. Within a week, however, assay results from AU-4 were released and the hole, which the week before had been branded a geophysical "dud", dramatically turned into the Ujina Deposit discovery hole. The assay results had returned 62 meters of 2.03% Cu, all of which was contained in secondary chalcocite, a mineral geologists on-site admitted could be difficult to recognize in drill core at times.

Ultimately an orebody of consisting of 1200mT of 0.8% Cu in protore, and 127mT of 1.83% Cu in secondary enrichment would be defined at Ujina. At the Collahuasi anomaly, zones of abnormally low resistivity (< 5ohm-meters) were subsequently drilled and found to correlate with deeply buried, massive, vein-hosted Cu mineralization over a wide area (Dick et al, 1993)

The discovery of the Ujina Deposit, and especially the thick secondary enriched zone, provided the economic boost required to make the development of the both Rosario and Ujina porphyry systems financially viable. Open-pit mining at Ujina started in 1998.

Conclusions

All major ore-systems in the Collahuasi mining camp produce distinct, but diverse, IP and resistivity signatures.

Low resistivities (~ 10 ohm-meters) at Ujina appear to relate to secondary ore, while at La Grande they appear to be derived from massive sulphide veins. Strongest IP response on the property is related to near-surface pyritic halo mineralization.

In light of the valuable insights provided (with the benefit of hindsight) by the 1979 IP survey on the Collahuasi property, a survey which in the present-day would all too readily be considered antiquated and inferior, and not worth the time reviewing and digitizing, it is suggested that explorationists take special care before dumping their pre-digital era company archives.

References

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Acknowledgments

I would like to acknowledge geologists Richard Moore, Falocnbridge, and Larry Dick, formally of Chevron Minerals, who I worked closely with on the project and whose faith in the ultimate potential of the Collahuasi Project never wavered. I would also like to dedicate this case-history to Charlie Swift, also formally of Chevron who, but for an unfortunate accident soon after the Ujina discovery was made, would no doubt be co-authoring this paper with me.