Update on the Cañaribamba epithermal gold prospect, southern Shyri, Azuay Province, south Ecuador

NNE over NNW-elongate Shyri diatreme in depression; dacite dome to left and and rhyodacite neck on horizon. Gringo vein is south of house (lower middle of photograph), hosted by diatreme; other veins out of sight, upper left

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Summary and recommendations

The vein systems associated with the large diatreme complex at Cañaribamba have good evidence of locally developed bonanza grades, not uncommonly in excess of 10 g/t Au. There are at least two areas of veins, in the north and south, separated by ~3 km in this large, multiple diatreme complex; the western portion of the diatreme complex has yet to be investigated fully. Some of the veins are hosted by diatreme breccia, others outside, and some likely on the margin of diatreme breccias; structures in the basement Saraguro formation place important controls on the development of the veins, both in the wall rock and the overlying diatreme breccia, particularly where the diatreme has a flare at a shallow emplacement depth.

The vein systems, and indeed the whole of the related diatreme complex, bear similarities in areal size and vertical extent (at least 300-400 m) to other diatreme-related vein systems, such as the large deposits of Rosia Montana, Kelian, and Acupan. In addition, both Rosia Montana features QIP (quartz-illite-pyrite) alteration as a halo to the mineralized veins, and at Rosia Montana, adularia-quartz alteration, as seen at Gringo, is most closely associated with the mineralized vein system.

The importance now is to continue to add detail to the picture of the large system at Cañaribamba, with its multiple diatreme events and various veins, with variable hosts and vein orientations. Integrating the results of detailed mapping of the geology, structure, and alteration plus mineralization with the geophysical indications will provide the best constraints on drill hole targeting. Drill holes will also provide useful information on the nature of the diatremes, and structure and alteration in the host rocks, as well as mineralization. Initial drilling should test shallow depths, ~100 m, to establish orientations of structures, but drilling to at least 300 m true depth will be necessary to assess the potential of this system.

Recommendations

• The complicated geology, particularly the nature and distribution of the alteration, needs to be mapped in more detail, to determine the timing relative to mineralized veins. Keep alteration mineral assemblages, determined in the field and validated by PIMA, in the mapping results, to look for subtle variations in mineralogy, before summarizing groups of assemblages into alteration types.

• Continue to map structures to establish a model of the veins, prior to developing targets for drill testing. Veins inside, outside, and on the margin of the diatreme complex may have complicated and multiple controls.

• Fully interpret the results of the magnetic and IP resistivity surveys with the geology and alteration to get the most insight from the geophysical work, prior to establishing drill targets.

• Initial drill testing should be conducted after the recommended program is complete and synthesized, with drill holes initially targeting the upper 100 m, and then extending to 200 m depth based on the preliminary results. Drill targets will focus not only on well-determined extensions of mineralized surface structures, but may also target zones indicated by alteration zonation. Determining the strikes and dips of the margins of the diatreme complex, between diatremes as well as with the basement, should also be a focus of early drilling.
Introduction

Mr. Mike Basha, VP Exploration of Cornerstone Resources, Inc., requested the author to revisit the Cañaribamba prospect in the southern portion of the Shyri property, Azuay Province, south Ecuador. The author was accompanied by Basha as well as George Smith, Exploration Manager, Rene Revelo, Santiago Baca, Servio Loayza, and Francisco Abad during one day in the field, 12 February. The trip was led by Dr. Scott Manske, who had been mapping in the area for the previous three weeks, and whose report is pending; Manske presented an overview of his work, built on that of others, during the morning of 11 February. A summary presentation was held on 13 February in Santa Isabel with all of these geologists and other attendees. Discussions with all these geologists and their ideas have been incorporated in this report, with thanks, particularly those by Manske on his recent work in the Gringo vein area, which was the focus of this visit. The northern area, 3-4 km north of Gringo, also associated with diatreme breccias and containing the Pinglio, Alberto, Guabisay, and Ramos Potrero veins, was the subject of a day’s visit in August, 2006, and was discussed by Hedenquist (2006b, unpublished report to Cornerstone; lodged at http://www.cornerstoneresources.com/s/Ecuador.asp?ReportID=136203). George Smith and other Cornerstone staff assisted with preparation of the figures.

Fig. 1: Cañaribamba diatreme-related prospects, southern Shyri property, Azuay, south Ecuador. Location of principal vein systems shown; northern area of Pinglio, Alberto, Guabisay, and Ramos Potrero veins, ~0.7 km² inside heavy line, has a total of 1556 rock samples, with 162 samples returning >0.5 g/t Au (26 being >10 g/t). The Gringo vein, in the south, has float from historic workings returning bonanza grades as well.
Cañaribamba

The Cañaribamba veins are spatially related, and partially hosted by the Shyri diatreme complex, first identified by R.H. Sillitoe in a 1992 report when he examined the historic gold workings of the Gringo vein for a client. The diatreme is estimated to be nearly 4 km N-S and up to 1 km wide, with a 2-3 km diameter magnetic high adjacent to the western margin of the diatreme complex. Based on several periods of mapping, Bernardo Beate (2007, report to Cornerstone) concluded that the diatreme complex consists of multiple intrusions of diatreme breccia and dacite material; the presence of siliceous lacustrine sediments as fragments indicate that the diatreme was capped at some time by a shallow crater lake. Beate speculated, based on various observations of volcanic events that bracket formation, that the timing of the diatreme emplacement was ~5-6 Ma; for example, silicified fragments of the Late Miocene Turupamba Fm are contained in the diatreme breccia.

The Cañaribamba district contains numerous veins, hosted by the diatreme complex as well as the Saraguro volcanic basement. More than 2500 samples have been collected, although many are from low-grade (<100 ppb Au) wall rock. In the northern area of veins (Pinglio, Alberto, Guabisay, Ramos Potrero), a total of 162 samples to date have return >0.5 g/t Au (Fig. 1), with 26 samples being >10 g/t in channels and chips of vein quartz. Similarly, several 0.1 to 0.6 m wide veins in the southern, Gringo, area have returned bonanza grades of double digits; samples of vein float in this area of historic workings have also returned double digit values.

The apparently N-trending Gringo vein at the southern end of the diatreme complex is in an area with outcrops at ~2450 to 2340 m. In the northern area a series of veins outcrop with ~NNW strikes along a cross-strike direction of >1 km E-W. From west to east, the Pinglio stockwork through the Alberto vein down to Guabisay and Ramos Potrero veins are exposed from ~2700 m elevation down to <2400 m; outcrops of vein material are known down to <2200 m, and present-day workings are reported near the bottom of the stream valley, at 2000 m. Thus, there is an indication of mineralized stock works and veins in the northern area of at least 500 m, with the Gringo veins in the southern area corresponding to the lower half of this elevation interval.

A 3.5 x 2.5 km grid has been laid over the area; soil sampling has highlighted several anomalies, several associated with outcropping veins, as well as others at lower elevations, including one anomaly south of the Gringo outcrops. Geophysical surveys have been completed, both ground magnetics and IP resistivity; the results are now being integrated with the geology. The area of mapped diatreme complex corresponds well with a clearly defined magnetic low, consistent with a broad area of hydrothermal alteration; an extension of the low to the SE of the mapped southern margin of the diatreme complex is consistent with Manske’s conclusion (personal communication) that the diatreme is slightly larger in this area.
Fig. 2: View south from the location of the historic Gringo workings (left), down the valley ~500-800 m to outcrops of adularia-quartz alteration ~100 m lower in elevation, in stream cuts NE of the unaltered Shyri dacite dome (latter visible to right).

**Alteration at Gringo**

One of the new observations since the August, 2006, visit is based on the recent alteration mapping by Manske, with significant results particularly in the Gringo area. The silicification and pyrite along with illite alteration adjacent to the Pinglio veinlets, recognized previously by Cornerstone geologists, is typical of diatreme-hosted systems; it is termed QIP (quartz-illite-pyrite). To the south at Gringo, in addition to the presence of QIP, Manske (2007, personal communication and pending report) has recently recognized the occurrence of adularia-quartz flooding in outcrop. The area is south of the historic Gringo workings (Fig. 2), ~500 m south of the southern-most drilling conducted by Cogema, and nearly 100 m lower in elevation than the northern area of Gringo workings (Fig. 3). An old mine dump at further ~750 m to the south has illite-bleached rocks on the dump (Manske, 2007, personal communication). Manske has also recognized quartz-adularia altered fragments within the diatreme breccia, supporting other evidence for the diatreme to be a complex of multiple eruptive episodes, and also for the hydrothermal activity to be timed to diatreme formation, since it also hosts mineralized veins.

The four 1990s RC drill holes are reported to have been a maximum of 160 m, angled at -70 degrees in an E-W orientation; the unsighted drill logs are reportedly consistent with intersection of adularia-quartz alteration near the bottom of the holes, although the drill holes did not intersect any significant quartz veins. Since these drill holes were collared in an area of QIP alteration and the adularia-quartz flooding outcrops nearly 100 m lower in elevation, it is possible that an adularia-quartz horizon extends to an area beneath the historic workings.
Fig. 3: Area ~800 m south of Gringo workings (Manske Loc. 55), 2340 m elevation. a) N60E structure cutting diatreme, strong silicification, unsampled. b) Same outcrop, moderate quartz-flooded sample (some scratch mark) with adularia rhombs in matrix.

Both QIP and adularia-silica flooding were recognized at Rosia Montana, a large diatreme and dome-hosted intermediate-sulfidation vein deposit in Romania, where these alteration types are spatially related to higher grades (Manske et al., 2006, SEG January Newsletter). The QIP alteration is an outer halo to the adularia-quartz flooding that is very brittle and has been best fractured and mineralized (Fig. 4).

Fig. 4: Alteration distribution within the diatreme-hosted dacite domes at Rosia Montana, based on 1:250 scale mapping (from Manske et al., 2006, SEG Newsletter, no. 64). Quartz-adularia flooding (Ad, in pink) is host to most of the higher-grade structures, and this has a halo if QIP (quartz-illite-pyrite) alteration, in blue.
Discussion

The Canaribamba diatreme-associated epithermal vein system has evidence for significant mineralization over a vertical interval of >300 m, probably 400 m or more, albeit not indicated from the same vein system. Such a large vertical interval of mineralization is typical of diatreme-associated intermediate sulfidation veins around the world (e.g., Acupan, Baguio district, Philippines, 800 m; Kelian, on the island of Borneo, Indonesia, ~600 m; and Rosia Montana, Romania, ~400 m). Each of these large deposits (from >4 to >10 Moz, the first two mined out, the latter in development) is closely associated with a diatreme complex; veins at each deposit cut diatreme and/or diatreme-intruded domes.

At Cañaribamba there is the suggestion on the eastern margin of the southern portion of the diatreme complex for a shallow depth to basement (Manske, 2007, personal communication); one or more of the 1990s drill holes may have bottomed in basement tuff, based on an interpretation of drill hole cuttings. The diatreme at Rosia Montana has a large surface area (Fig. 5), like at Cañaribamba (Fig. 1). Such large areas are due to relatively shallow levels of erosion, coupled with the fact that diatremes develop a flare during formation of the volcanic-driven eruption near the surface; this results in the diatreme complex being much larger than the root zone(s) (Fig. 5). By contrast, the surface area of the diatreme that hosts most of the 8 Moz of mined ore at Kelian, Indonesia, is only ~500 m in diameter; this is due to the fact that there has been nearly 1 km of erosion below the paleosurface at Kelian (van Leeuwen et al., 1990, Journal of Geochemical Exploration), exposing only the deep root of the diatreme at the present surface. Compare the size of this diatreme-hosted vein system at Kelian with the area of the vein systems in the northern Cañaribamba diatreme complex (Fig. 1; area inside heavy line).

![Fig. East-west cross section through the Rosia Montana diatreme complex; present surface is shown, ~200-300 m below paleosurface. The early diatreme (grey) is cut by dacite domes (crystal stipple) that host a majority of vein-related higher grade mineralization (adapted from Connor et al., 2003). The typical shallow flare of large diatremes is evident. Late diatreme breccias (irregular fragment stipple) cut the early diatreme and domes. Mineralization is hosted largely in the upper 300 m, with 2/3 of ore within the two dacite domes. Level of erosion of the Kelian deposit (8 Moz vs the >10 Moz Rosia Montana deposit) is shown; the much deeper level of erosion at Kelian (schematically illustrated with the red dashed line) accounts for the smaller area of diatreme exposed there, ~500 m in diameter. The level of exposure due to erosion at Cañaribamba appears more similar to Rosia Montana than Kelian.](image-url)
On the basis of this reasoning, that diatremes always flare near the surface, and the arguments put forward by Hedenquist (2006b) for a relatively shallow depth of erosion at Cañaribamba (e.g., vein types and textures at Pinglio), perhaps a few 100s m at most, the schematic N-S section through the diatreme complex was constructed (Fig. 6). The presence, to date, of only QIP (quartz-illite-pyrite) alteration at Pinglio, the highest elevation outcrops of veins at >2700 m, versus the higher temperature adularia-quartz alteration at Gringo, is consistent with more erosion at Gringo, and the lower elevations. At the same time, Beate (2007 report) has argued for multiple diatremes in the complex, consistent with geophysical (magnetic) evidence, and thus there may have been multiple surface levels; however, it is unlikely for there being a significant difference, >100 m, between the surface over 3-4 km in this volcanic terrain.

The significance to these observations are that there is likely to be significant vertical intervals of potential mineralization remaining at Cañaribamba, with significant grades in veins, as indicated by the results from vein systems in and adjacent to the north and south portions of the diatreme complex. The higher temperature adularia-quartz alteration, indicating a more proximal location to the potential upflow zones – feeders – of the mineralized vein systems, outcrops at ~2360 m elevation. This is positive for both Gringo as well as less eroded veins in the north. If adularia-quartz is not found at the surface in the north, it may be expected by drilling 200-300 m in the vicinity of Pinglio, if the level of the north and south mineralization is roughly comparable.

Fig. 6: North-south fact and interpretive section, Cañaribamba (no vertical exaggeration, 4 km N-S, each grid 200 m); present surface is shown in green, with over 600 m of slope to lower elevation in the south. Locations of Pinglio and Gringo veins and mineralization, to north and south, respectively, are shown, along with a schematic distribution of quartz-illite-pyrite (QIP) alteration (blue). Even more schematic is the distribution of adularia-quartz alteration (pink), outcropping below 2400 m elevation in south Gringo, extended to an area below the historic workings; the presence of adularia-quartz alteration at depth at Pinglio, predicted from an analogy with Gringo (and Rosia Montana, see Fig. 4), is speculative. There is a gold-in-soil anomaly associated with the area of outcropping adularia-quartz. The potential importance of adularia-quartz is that it is the immediate host alteration to the principle veins in other diatreme-related intermediate sulfidation deposits (e.g., Rosia Montana; Manske et al., 2006). The approximate N-S position of the Shyri unaltered dacite dome, off section to the west, has been projected (dashed lines).
Summary and conclusions

The vein systems associated with the large diatreme complex at Cañaribamba have good evidence of locally developed bonanza grades, not uncommonly in excess of 10 g/t Au. There are at least two areas of veins, in the north and south, separated by ~3 km in this large, multiple diatreme complex; the western portion of the diatreme complex has yet to be investigated fully. Some of the veins are hosted by diatreme breccia, others outside, and some likely on the margin of diatreme breccias; thus structures in the basement Saraguro formation, some probably related to diatreme emplacement and others pre-existing, will place important controls on the development of the veins, both in the wall rock and also in the overlying diatreme breccia, particularly where the diatreme has a flare at a shallow emplacement depth.

The vein systems, and indeed the whole of the related diatreme complex, bear similarities in areal size and vertical extent (at least 300-400 m) to other diatreme-related vein systems, such as the large deposits of Rosia Montana, Kelian, and Acupan. In addition, both Rosia Montana features QIP (quartz-illite-pyrite) alteration as a halo to the mineralized veins, and at Rosia Montana, adularia-quartz alteration, as seen at Gringo, is most closely associated with the mineralized vein system, due to flooding of the wall rock adjacent to the focus of high-temperature fluid flow.

The importance now is to continue to add detail to the picture of the large system at Cañaribamba, with its multiple diatreme events and various veins, with variable hosts and vein orientations. Integrating the results of detailed mapping of the geology, structure, and alteration plus mineralization with the geophysical indications will provide the best constraints on drill hole targeting. Drill holes will also provide useful information on the nature of the diatremes, and structure and alteration in the host rocks, as well as mineralization. Initial drilling should test shallow depths, ~100 m, to establish orientations of structures, but drilling to at least 300 m true depth will be necessary to assess the potential of this system.

Recommendations

- The complicated geology, particularly the nature and distribution of the alteration, needs to be mapped in more detail, to determine the timing relative to mineralized veins. Keep alteration mineral assemblages, determined in the field and validated by PIMA, in the mapping results, to look for subtle variations in mineralogy, before summarizing groups of assemblages into alteration types.

- Continue to map structures to establish a model of the veins, prior to developing targets for drill testing. Veins inside, outside, and on the margin of the diatreme complex may have complicated and multiple controls.

- Fully interpret the results of the magnetic and IP resistivity surveys with the geology and alteration to get the most insight from the geophysical work, prior to establishing drill targets.

- Initial drill testing should be conducted after the recommended program is complete and synthesized, with drill holes initially targeting the upper 100 m, and then extending to 200 m+ depth based on the preliminary results. Because of the relief of over 300 m in the area, relatively shallow holes (100-350 m) can test a wide range of depth potential over the prospect; drilling to at least 300 m depth will be necessary to test the potential of root zones.
• Drill targets will focus not only on well-determined extensions of mineralized surface structures, but may also target zones indicated by alteration zonation. Determining the strikes and dips of the margins of the diatreme complex, between diatremes as well as with the basement, should also be a focus of early drilling.
Qualifications

I, Jeffrey W. Hedenquist, of Ottawa, Canada, hereby certify that:

• I am President of Hedenquist Consulting, Inc., incorporated within the province of Ontario. I am an independent consulting geologist with an office at 74 Greenfield Avenue, Ottawa, Ontario, K1S 0X7, Canada; telephone 1-613-230-9191.

• I am a graduate of Macalester College, St. Paul, Minnesota, USA (B.A., Geology, 1975), The Johns Hopkins University, Baltimore, Maryland, USA (M.A., Geology, 1978), and the University of Auckland, Auckland, New Zealand (Ph.D., Geology, 1983).

• I have practiced my profession as a geologist continuously since 1975, working as a researcher for the U.S. Geological Survey, the New Zealand Department of Scientific and Industrial Research – Chemistry Division, and the Geological Survey of Japan until the end of 1998. I have published widely in international refereed journals on subjects related to epithermal and porphyry ore-deposit formation and active hydrothermal systems. I consulted to the mineral industry and various governments as a New Zealand government scientist from 1985 to 1989, and I have been an independent consultant since January, 1999.

• I am a Fellow of the Society of Economic Geologists and have served as an executive officer, and am a member of the Society of Resource Geology of Japan and the Geochemical Society. I was Editor of the 100th Anniversary Publications of Economic Geology, am an editorial board member of Economic Geology and Resource Geology, and have previously served as editorial board member of Geology, Geothermics, Journal of Exploration Geochemistry, Geochemical Journal and Mineralium Deposita.

• This report is based on information provided to me by Cornerstone Resources, publicly available reports, published or on the Internet, and personal observations in the field.

• I have no direct or indirect interest in Cornerstone Resources, in the properties described in this report, or in any other properties in the region.

• I hereby grant permission for the use of this report in its full and unedited form in a Statement of Material Facts or for similar purpose. Written permission must be obtained from me before publication or distribution of any excerpt or summary.

Hedenquist Consulting, Inc.

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Jeffrey W. Hedenquist, Ph.D.
President

Date: February, 2007

Ottawa