Mineral occurrences in the area of the king tut mine, La Rioja province, Argentina

Alan L. Sangster
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MINERAL OCCURRENCES IN THE AREA OF THE KING TUT MINE, LA RIOJA PROVINCE, ARGENTINA

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INTRODUCTION

The area of interest is located on the western side of the “Sierra de Famatina” about 50 km north of the village of Vinchina (Figure 1). Four sites of interest were visited; the King Tut occurrence, an occurrence of breccia, and the Horacio barite occurrence in Quebrada el Salto; and an area reported to contain elevated Ni lithogeochemistry in Quebrada Alumbrera (Figures 2A,B, 3A,B). The objective of the visit was to characterize the occurrences and suggest programs of work to enhance exploration interest in the area if warranted.

Previous work in the area is extensive. An excellent unpublished report by Cravero (1988) summarises the geology and briefly summarises the results of an examination of mineralized sites. Cravero’s report cites several reports by earlier workers.

Topography in the area is extremely rugged with base elevations in the order of 3000 metres, steep mountainsides, and mountaintops between 4500 and 5500 metres.

REGIONAL GEOLOGY

The Famatina Range in the King Tut area consists of a lower sequence of Ordovician argillaceous rocks, intruded and covered by Devonian high level rhyolitic intrusions and terrestrial extrusive rocks, and overlain by Carboniferous sedimentary rocks (Figure 2, 2B). Two Ordovician units have been defined. The Volcanito Formation, of Tremadocian age, consists of green and black argillite and occurs north west of the area of interest. The Suri Formation consists of green and black argillite and occurs north west of the area of interest. The Suri Formation consists of finely laminated metasedimentary rocks varying in composition from greywacke to shale, and contains foliation parallel “spilitic” basalt flows and/or dykes, breccias, and “keratophyre”. The Ordovician rocks are unconformably overlain by Devonian Morado Formation consisting of ignimbrites with associated subvolcanic rhyolite porphyry intrusions that occur in the higher central core of the mountain range. Carboniferous molasse of the Agua Colorada Formation unconformably overlies the older formations.

The argillaceous and arkosic metasedimentary rocks of the Volcanito and Suri formations have been intensely deformed about north-south fold axes but thermal metamorphic grade is low.

FIELD OBSERVATIONS

Mina King Tut

The King Tut Co-As-Au vein is located in the Suri Formation on the south side of the lower Quebrada El Salto, 100 metres above a small waterfall. The vein is exposed in 4 workings (Figure 4A,B) on the south side of the valley. The underground workings total 235 metres of which 90 metres are drifts on the vein (Cravero, 1988). Level 0 at the base of the hill was flooded at the time of the visit and was not accessible. Level 1, about 20 metres above level 0, was entered. It consists of a crosscut to the vein and about 20 metres of drifting on the vein. The vein and wallrock are very highly oxidized limiting the quality of data that could be obtained.

The vein appeared to consist of several narrow zones of quartz over a width of about 1 metre with very spotty silver-grey metallic mineralization. The minerals associated with this element assemblage are notoriously difficult to identify by visual methods.

The vein appears to be quite young as it cuts the foliation in the Suri Group as well as relatively
undeformed dykes or flows that parallel the foliation. Down the valley at the location of the small waterfall, a swarm of <2 cm thick quartz veinlets striking sub-parallel to the King Tut vein, and along strike from it, cut massive, albitized basalt (Figure 5A,B). No sulphide mineralization was seen in these veins.

**Brecia**

Cravero (1988) reports that traces of base metal mineralization are associated with low-level lithochemical anomalies in rocks mapped as "spilitic breccia". However, lithochemical analyses carried out to date do not indicate metallic element contents of potential economic significance.

A brief stop was made at an outcrop of breccia about 400 metres above the King Tut occurrence (Figure 6). The breccia consists of fragments of a very fine-grained green volcanic rock that vary from pea sized to 1 metre in diameter in a matrix of similar composition. The fragments are sub angular to angular in shape. The breccia has been described as a "spilitic breccia" which seems to suggest that the rock is a brecciated Na-metasomatized mafic volcanic. The rock contains a few percent very fine grained pyrite and the presence of chalcopyrite, galena and enargite is reported from petrographic examination, though analyses apparently show only background levels of Cu, Pb and Au (Cravero, Personal Communication). No base metal minerals were seen in our examination of the outcrop visited.

**Horacio Barite Occurrence**

The Horatio barite occurrence is at an elevation of about 3700 metres, 700 metres above the King Tut occurrence. The vein consists of a 600 metre long by 1 metre wide vein of massive barite striking 355 degrees and dipping at 42 degrees east. The vein intrudes rhyolite near the east contact of a subvolcanic rhyolite porphyry intrusion. The rhyolite contains minor disseminated pyrite near the contact with the vein. Only the south end of the vein was examined.

**Quebrada Alumbrera Nickel Anomaly**

In quebradas Alumbrera and Cuchillas, Cravero (1988) reported a lithogeochemical anomaly with high Ni (500 to 3000 ppm) and modest Co values in cherts, argillites and felsic igneous rocks of the Suri Formation (Figures 7A,B). Parts of two days were spent examining and sampling these rocks which consist of a series of white to grey cherts, siliceous siltstones, and felsic igneous rocks. Most of the rocks sampled are extremely hard and siliceous and though some are pyritic, pyrite is far from a universal component of these rocks. The rusty weathering appearance of the "altered zone" may result from a pyrite content on joints and fractures that is entirely oxidized in surface exposures. The area of interest is large with dimensions of 300 x 500 metres in Quebrada Alumbrera.

No indication of mineralization that would produce the Ni-Co results was seen.

**LABORATORY INVESTIGATIONS**

Thin sections were prepared for 4 specimens of mineralization from the King Tut Property, La Rioja, Argentina. The samples were briefly examined under a petrographic microscope and in greater detail using a scanning electron microscope (Figures 8A,B; 9A,B; 10A,B). The results are as follows.

The principal mineral phase is arsenopyrite ((Fe,Co)AsS) in quartz gangue (Figure 8A, 10A). Cobaltite (CoAsS) (Figure 8A) is present, though in lesser amounts than arsenopyrite. Compositions of both the arsenopyrite and cobaltite are heterogeneous with regard to Fe-Co solid solution and it might be mineralogically (and academically) interesting to look into these compositional variations in some detail. The arsenopyrite was X-rayed to look for the presence of glaucodot ((CoFe)AsS), which was not found. The inhomogeneity must indicate deposition under markedly non-equilibrium conditions. Other sulphides present included pyrite (Figure 10B) with traces of chalcopyrite (Figure 9A). Accessory and trace minerals include Bi and/or BiS, BiTe, and galena as very small inclusions in arsenopyrite. Minor chalcopyrite is present (Figures 8B, 9B, 10A). Most of the sulphide minerals have been highly fractured and invaded by quartz.

No Au, Ag, Sb, or Ni were found in the sections examined. Detection limits for the SEM for these elements is from 0.5 to 1 per cent. On this basis, the SEM examination precludes the existence of minerals containing these elements as major components of the material analysed but does not preclude the presence of these elements in trace amounts.

The main silicate observed is mainly quartz with accessory chlorite and traces of calcite. Quartz is the most abundant gangue mineral and has been extensively deformed. Sub-grain textures are well developed and the quartz has strong undulose extinction indicating that the vein has been subjected to metamorphism after formation.
DISCUSSION AND RECOMMENDATIONS

King Tut Occurrence

The King Tut occurrence has maximum horizontal dimensions of 100 metres and has been tested over about 80 metres of vertical extent. The exposed mineralization is sporadic, narrow and would have to be extremely high grade (Au) to support mining over a conventional mining width. The mineralization could have the largest extent in the vertical dimension. The plunge of the occurrence could more than likely be determined by a structural study of the vein area but this does not appear warranted at the present time. The area is reported to have been thoroughly prospected without encountering other similar mineralization.

In the preliminary version of this report, the King Tut vein is tentatively classified within the group of "5 element veins" as summarised by Kissin (1992). "5 element veins" are generally composed of sulphides and arsenides of Co-Ni-Ag-Bi in vein carbonate but compositions are known to vary widely. Some districts for example contain significant U and Ba.

The examination carried out above has caused me to revise my opinion and I would suggest that the vein is more likely a sediment-hosted gold occurrence as are recognized in many Precambrian and Paleozoic terrains. These veins typically occur in flysch proximal or distal to mafic volcanic sequences and are dominated by quartz with arsenopyrite and pyrite mineralization. Trace mineralization is commonly gold with associated traces of Bi, Te and like elements. Cobalt at the levels found at King Tut occurrence are not common and it is unusual in this regard.

The following work is recommended:

1. Broad-spectrum chemical analyses should be carried out on 2 samples if not already done to permit accurate chemical modelling of the vein.

2. Sulphur isotopic analyses should be carried out on 2 or 3 samples of vein sulphide to constrain the source of the sulphur present in the veins.

Breccia

The breccias are an interesting appearing rock, however, except for the presence of very finely disseminated pyrite, there seems to be little to recommend pursuit of this unit as a source of commercial mineral deposits. Chemical analyses are reported to be low and no indication of commercial mineralization is evident. The only suggestion that I will make is to analyses a selection of 10 to 15 samples from a wide area for traces of gold if this has not already been done. This opinion is based on an examination of only one outcrop area.

Horacio Barite Occurrence

The Horatio barite occurrence is a thin vein in a remote area and is too remote for use as a source of industrial barite such as Mina Mapucha in Chubut Province. However, the vein should be analyzed for barite quality and compared with the specifications for pharmaceutical quality barite. Pharmaceutical barite is a very high value commodity and this vein might support a small operation among the local people. A broad-spectrum chemical analysis should be carried out on the pyritic halo material to determine metallic contents.

Quebrada Alumbreña Nickel Anomaly

The nickel geochemical anomaly in the Quebrada de Alumbrera is unusual. From the point of view of mineral deposit models, nickel mineralization occurs in two settings; 1) associated with mafic or ultramafic intrusions where the mode of occurrence is commonly a function of the original presence of nickel in an immiscible sulphide liquid; and 2) rarely as concentrations in highly reduced sedimentary rocks as for example sulphidic black shales. The occurrence here does not relate to either of these models suggesting that it may either be an artefact of the sample preparation or analysis procedure, or is some form of very exotic occurrence. My first guess would be that the very hard samples were prepared using a pulveriser with worn steel plates, resulting in the inclusion of metal from the plates in the samples analyzed. It is recommended that the 20 or so samples collected during the examination of the occurrence be reanalysed with sample preparation using a pulveriser with ceramic plates. The common trace elements (Au, Cu, Pb, Zn, Co, Ni, Bi, Sb, As, Ag) should be analysed to try and reproduce the previously indicated anomalies and determine other associated elements. If the values are not reproduced, earlier results should be disregarded and all other results of studies carried out using the same crusher/laboratory should be viewed with a great deal of suspicion. If anomalous results persist, a program of investigations should be designed at that time.
REFERENCES CITED


Claypool, G.E; Holser, W.T; Kaplan, I.R; Sakai, H; Zak, I., 1984. The age curves of sulfur and oxygen isotopes in marine sulfate and their mutual interpretation: Chemical Geology. v. 28; no. 3-4, pp. 199-260.


Figure 1. General location of the King Tut area, La Rioja, Argentina
Figure 2A: Geology in the area of the King Tut Occurrence, La Rioja Province. Mineral Occurrences: King Tut (1), Pyrite Breccia (2), Horatio barite (3).

Figure 2B: Geology in the area of the Quebrada de La Alumbrera (4) and Veta las Cuchillas (5) Occurrences (After Cravero, 1988).

LEGEND

QUATERNARY
- Alluvial deposits

CARBONIFEROUS
- Agua Colorada fm.
- Rhyolites

DEVONIAN
- Morado fm.
- Rhyolitic porphyry

ORDOVICIAN
- Suri fm.
  a. Paraconglomerates
  b. Hydrothermal alteration
- Spilitic basalts
- Spilitic breccias
- Keratophyres

Fault
Mine
Vein
Figure KT-3A: Access to the property was by 4 wheel drive UNIMOG via Provincial Road 21 and the valley of the Río Grande de Valle Hermoso, a distance of about 50 km north of the village of San Jose de Vichina.

Figure KT-3B: View looking east up Quebrada el Salto. The red arrows indicate (from left to right) the locations of the King Tut occurrence, the pyritic breccia and the Mina Horatio barite occurrence.
Figure KT-4A: Surface at the King Tut occurrence showing Level 0 adit (at valley bottom) and Level 1 adit (near top of photo). The vein strikes at approximately right angle to the erosion gully connecting the two adits.
Figure KT-4B  Outcrop exposed in cave-in at the site of the Level 2 adit. Red arrows locate white vein quartz, green arrows a "possible" fault subparallel to the vein.
Figure 5 A. Albitized basalt dyke west of the King Tut occurrence.

Figure 5 B. Quartz veinlets cutting mafic dyke on strike with the King Tut occurrence.
Figure KT-6: Spilitic breccia (Cravero, 1988) consists of a wide variety of clast sizes in a rock flour matrix. The breccia contains small quantities of visible pyrite with traces of other metallic sulphides.
Figure KT-7B: Oxidized sedimentary rocks in the vicinity of the Veta las Cuchillas Cu occurrence.

Figure KT-7A: Photograph of strata in the altered zone in Quebrada Alumbrera. The section consists of rhyolite (keratophyre), chert and clastic marine sedimentary rocks.
MINERAL OCCURRENCES IN THE AREA OF THE KING TUT MINE

Figure 8 A. SEM backscatter image, polished thin section KT-001-1.

Figure 8 B. SEM backscatter image, polished thin section KT-001-2.
Figure 9 A. SEM backscatter image, polished thin section KT-001-3.

Figure 9 B. SEM backscatter image, polished thin section KT-001-4.
Figure 10 A. SEM backscatter image, polished thin section KT-003-1.

Figure 10 B. SEM backscatter image, polished thin section KT-003-2.