

# THE DEVELOPMENT OF NIGER'S FIRST GOLD MINE

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## Abstract

The Samira Hill gold mine represents the first commercial gold project for the landlocked country of Niger in West Africa. It began production in October 2004 as the result of over 10 years of exploration and development work. There were several administrative, social and technical challenges that had to be overcome to realize the successful development of the project. The Samira mine is located on the geological structure known as the “Samira Horizon” which is developing as a promising district for additional discoveries and other mine developments.

## Introduction

Niger is a landlocked county located in French West Africa as shown in Figure 1 and is ranked by the United Nations as one of the poorest countries in the world. To date, the mining industry of Niger has consisted essentially of the uranium mines to the north and other commodities such as coal and industrial minerals. The development of the Samira Hill gold mine in 2004 represents the country's first gold mine, and the first major industrial development in the Liptako region of the country.

Etruscan Resources Incorporated, a Canadian junior mining company, became interested in the exploration potential of Niger back in 1993. It was granted its first exploration permit on the Koma Bangou concession in 1994 and began an exploration campaign later that year. Etruscan has since expanded its exploration efforts to other countries in Africa, with programs in Mali, Burkina Faso and Côte d'Ivoire. Etruscan also has developed an alluvial diamond operation in South Africa in 2002.

The Samira Hill Gold project is located on the Tiawa mineral concession 125 km west of the capital city of Niamey. Etruscan acquired the concession in 1997 and carried out several drilling campaigns independently and through an option agreement with Placer Dome. Placer declined to exercise its option in 1998 and by 1999 Etruscan had completed a bankable feasibility study on Samira which was updated in 2000. However, the low

gold price and poor market conditions at the time made it difficult to finance the project. In 2000, Etruscan decided to joint venture the project with another Canadian junior company, Semafo Inc. who committed to finance and develop the project.



**Figure 1.** – Map of Africa showing the location of Niger and the Samira Hill Gold project.

A commercial decision to proceed with the project was taken in May 2003, and the project was launched the following month. Construction was completed in August 2004 and the first gold was poured in late September of that same year. Table 1 gives a timeline from first discovery of the Samira Hill deposit to commercial development, a period spanning over 10 years.

## Geology and Reserves

Gold was initially discovered by local “orpailleurs” in the Liptako region of western Niger in the early 1980's. In 1993, the Republic of Niger completed a 5-year multi-disciplinary regional mapping, prospecting and

geochemical survey to document the gold occurrences. The Samira Hill and Libiri gold deposits were identified as isolated, discrete anomalies by this survey in an area with few orpailleur workings. The Libiri deposit is located on the adjacent Saoura concession.

**Table 1.** – Timeline from first discovery to commercial development of the Samira Hill gold project

- 1989 - 94: Discovery of Samira gold deposit by EDF Program
- 1997: Acquisition of the Samira deposit by Etruscan
- 1996 – 98: Various drilling campaigns completed.
- 1998 – 99: Bankable feasibility study (BFS) completed on Samira
- 1999: Adjacent Libiri deposit acquired. Mining permits granted. Drilling program on Libiri completed
- 2000: Entered joint venture with SEMAFO. Raw water pipeline and water dam installed. Updated feasibility completed including the Libiri deposit
- 2003: Financing raised and the project launched in June.
- 2004: Project completed and first gold bar poured in September.

Lower Proterozoic (Birimian) volcanic and volcano-sedimentary greenstone belts intruded by granitoid plutons underlie the Liptako region. The greenstone belts are typically folded along NE trends and generally consist of fine-grained sedimentary rocks, and volcanic rocks. The metamorphic grade of the greenstone belts ranges from lower greenschist to amphibolite depending on the distance from the enveloping granitoids. Extensive weathering has produced areas of laterite over the region.

Granitoid and meta-volcano-sedimentary rocks of the Sirba greenstone belt underlie the Tiawa and Saoura concessions. Gold mineralization in the Samira and Libiri deposits are hosted by a graphitic sedimentary sequence known informally as the Samira Horizon. In general terms, the Samira Horizon (see Figure 2) can be subdivided into two distinct suites consisting of an upper sequence of alternating argillites, siltstones and greywackes and a lower sequence of alternating graphitic siltstones, graphitic argillites and greywackes. Two thick volcanic units along the hanging wall and footwall contacts bound the sediments.

Mineralization in the Samira and Libiri gold deposits is locally controlled by the permeability and porosity of the host sediments. Shearing and brecciation suggests a progressive deformation-alteration-mineralization process during the second deformation. Sulphide mineralogy includes arsenopyrite, pyrrhotite, pyrite and trace amounts of galena and stibnite. Gold typically occurs along the sulphide grain boundaries.

The Samira Hill project is based on an initial reserve estimate of 10 million tonnes grading 2.23 gms/tonne.

### **Project Description**

The Samira Hill project encompasses the following broad elements. A site plan map is shown in Figure 3:

- Contract open-pit mining
- Three pits: Samira Main, Samira East & Libiri.
- 2.0 MTPA carbon-in-leach (CIL) Plant
- Self-generated power supply
- Seasonal water supply and 4.5 million m<sup>3</sup> dam

Mining will occur from the three pits to a maximum depth of approximately 240 meters (Samira Main). Much of the early mining will be free digging followed by drilling and blasting of the deeper materials. The ore varies from shallow oxide or saprolite to transition materials with varying degrees of oxidation and carbon content.

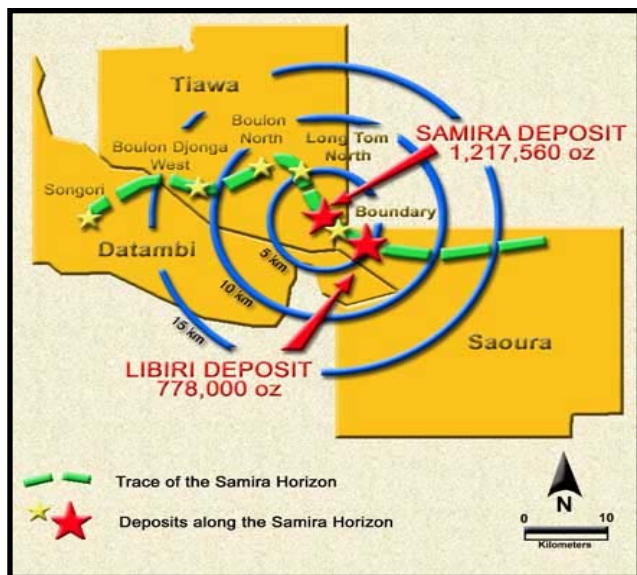
The ore will be crushed and ground followed by treatment in a conventional carbon-in-leach (CIL) milling circuit for gold extraction. The capacity of the plant is rated at 2.0 MPTA on oxide ore and 1.3 MTPA on the deeper transitional material.

No reliable grid power supply was available to the project. Consequently, the power supply is provided by a dedicated 6.0 MW Caterpillar power plant that supplies the plant and the infrastructure including the mine camp and the water pumping stations.

The raw water is supplied from a 4.5 million cubic meter water reservoir, which is seasonally charged from a 7 km pipeline to the Sirba River over the rainy season (June to September). The climate is very dry most of the year with the evaporation rate being approximately twice the annual rainfall. The seasonal pumping and storage option, with the appropriate allowances for evaporation, proved to be the most feasible option.

Based on current reserves, Samira Hill has a project life of seven years with a forecast total gold production of 615,000 ounces. The annual gold production is forecast

to range from 135,000 ounces in Year 1 to 40,000 in Year 7. Concurrent exploration over the mine life will be geared to identifying new ounces within the vicinity of the mine in an effort to maintain the higher levels of production.



**Figure 2.** – A plan map showing the Samira horizon

### Treatment Plant

The project was initially proposed as a heap leach operation. Further metallurgical testing of the deeper reaches of the ore zones indicated limited recovery by heap leaching due to preg robbing. As well, the 1998 drilling program proved up more transitional ounces than originally projected. This, combined with the marked decrease in recovery with depth (over the transitional zone), caused a reassessment of the processing strategy and the selection of the CIL option.

The gold mineralization is very finely disseminated and occurs in three broadly distinguishable zones: saprolite or oxide, transition and bedrock. The targeted project resource includes the cyanide leachable saprolite and transitional ores. The saprolite is a highly oxidized, unconsolidated material that occurs from surface to an approximate depth of 60 metres. The transitional zone, which is characterized by a higher graphitic content and a varying degree of oxidation, occurs largely between the shallow saprolite and the deeper bedrock.

The deeper bedrock proved unleachable or refractory under the proposed CIL scenario. An oxidation process prior to leaching would likely be needed to successfully treat this ore type.

A simplified plant flow sheet is given in Figure 4. The run-of-mine (ROM) ore is delivered to a tipping or ore-receiving bin. The -750 mm material is fed by way of an apron feeder into a jaw crusher where it is crushed to -150 mm. The crushed material is either fed directly to the SAG (semi autogenous grinding) mill or to a stockpile where it can be reclaimed by a front-end loader.

The target grind from the SAG mill is 80% -75 µm. The ground material is fed to the CIL tanks where it is mixed with a cyanide solution (at high pH) and carbon for gold leaching and carbon loading. The loaded carbon is screened from the leached material and the gold eluted, electrowon, smelted and poured in approximate 15 kg bricks assaying plus 90% gold.

The mill tailings are pumped to the tailings impoundment where they are allowed to settle, and the water decanted and returned to the plant. It is estimated that 30% of the tailings water will be reclaimed and the remainder lost to evaporation and as bound water in the settled tailings matrix.

There are plans to add a second grinding mill in the early years of operation to better handle the deeper transitional material and to maintain the higher throughputs.

### Project Challenges

The Samira Hill project is the first commercial gold mine for Niger. Perhaps more importantly, it represents a scale of commercial development in the country not seen in many years. The mine or project site is located in the southwestern part of the country in the Liptako region near the border with Burkina Faso. This area, typical of many areas in West Africa, has been largely removed from any significant industrial development throughout generations.

The population of the Liptako region resides in numerous small villages scattered throughout the landscape, mostly along the Niger River. The residents are largely involved in life sustaining activity like farming (millet) and raising livestock (sheep and cattle). There has been little movement of people from their birth areas or villages and, prior to the Samira Hill project, contact with the outside world had been limited. Living off the land has been a way of life since the lands were first inhabited, and the advent of the Samira Hill project has brought a measure of change and expectation among the immediate communities.

In Niger, there have been many administrative, social and technical challenges to address and resolve over the

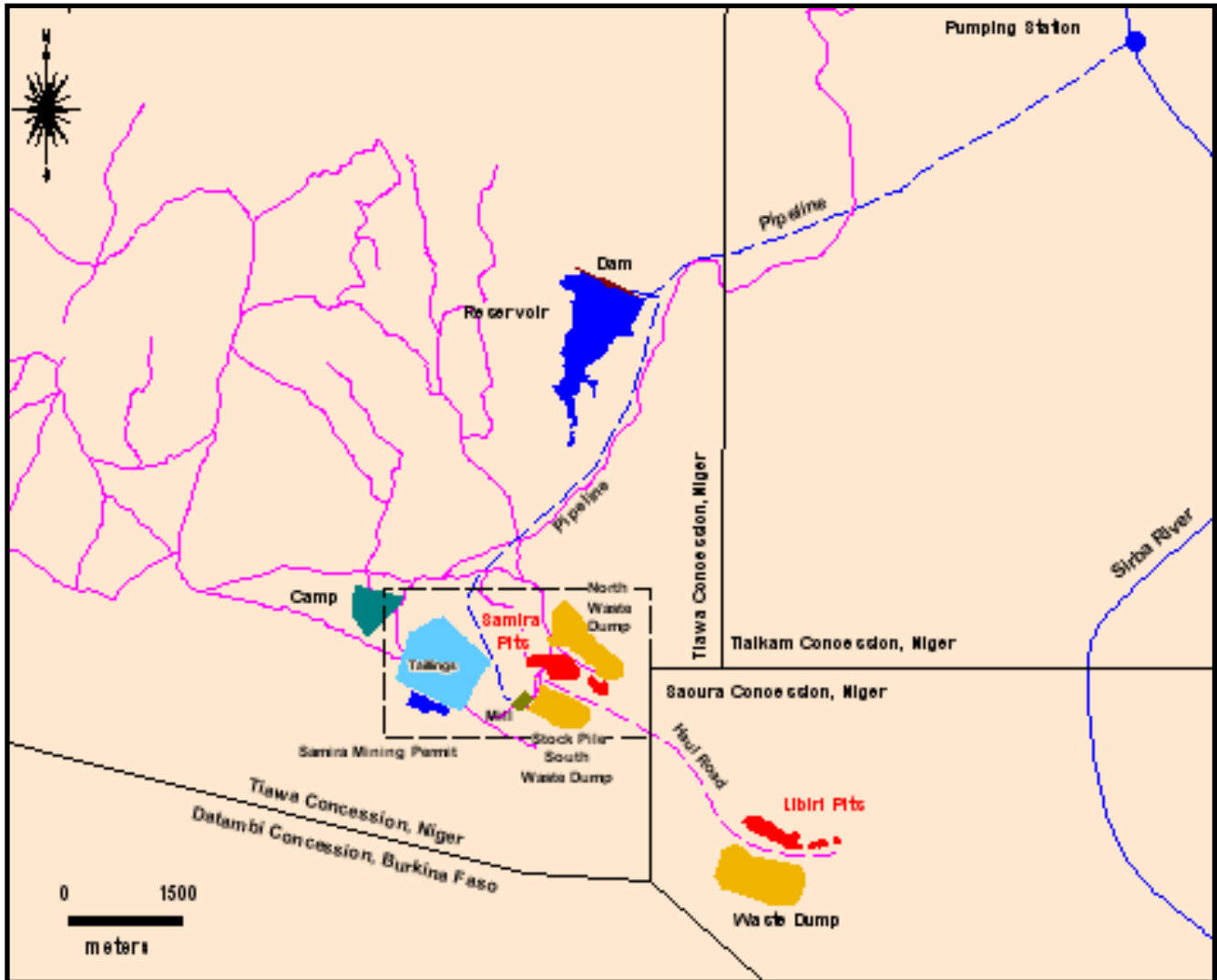


Figure 3. – An overall site plan

decade leading up to the eventual commercialization of the project. These are now discussed:

**Infrastructure.**

The infrastructure in and around the project site is very limited. In the early years during the exploration phases, there was a real difficulty with communication and data transfer. The national telephone system was very primitive and unreliable and there was no service in the vicinity of the project area. The application of satellite technology in recent years has certainly improved the situation.

Grid power and a year round water supply are unavailable. The application of dedicated generator power is typical in many projects throughout West Africa

because of unreliable or unavailable local grid power. It is not a problem unique to Samira.

A particular challenge with Samira however, was the sourcing of adequate raw water for the plant. There was adequate borehole water identified for limited potable water consumption but it was inadequate for the large volumes necessary for the CIL plant. The nearby Sirba River (7 km) runs seasonally during the rainy season and contains abundant water for only several months of the year. It became obvious that the only feasible solution was to harvest this water during the rainy season and provide enough storage for consumption over the remainder of the year.

At considerable cost to the project, a reservoir having a capacity of 4.5 million cubic meters was constructed

together with a pipeline from and pumping station at the Sirba River. The dam itself measures 1 km across and required in excess of 250,000 cubic meters of earthworks to construct. The pumping station is designed to pump a minimum of 1800 cubic meters per hour over an approximate four-month period. This, combined with the natural run off, was deemed adequate to meet the required volume capacity.

### ***New Mining Act enacted in 1993***

The Mining Act of Niger covers all aspects of mining from prospecting, exploring, mining, processing and refining to the sale of mineral substances. There are several permits that can be issued under the Mining Act including those pertaining to exploration and exploitation.

The Samira Hill project represents the first project to receive permitting for exploration and later exploitation activity under the new Mining Act. The regulations guiding the interpretation and implementation of the Act were still in part, being developed, and the Ministry of Mines experienced some delays with respect to responding to the various applications. The Samira Hill experience essentially served as a Ministerial test case in many respects. The challenge was to ensure adequate processing and timely issuance of the permits within the project time constraints.

To facilitate the technical reviews and the administrative handling, especially at the feasibility stage, the Company adopted a proactive relationship with the Nigerien administration and authorities. Inter-departmental committees were established to review the feasibility documentation and the Company funded all out-of-pocket costs for such meetings. The Company also provided funding for several of the technical bureaucrats to attend technical conferences on mining and processing technology. Other training programs and forums were also funded, and this has become an ongoing commitment.

An area where legislation was really lacking was that pertaining to the environment. All of the feasibility work assumed World Bank standards, and there was much effort taken to assist the Ministries on this important element, especially on the handling of cyanide tailings. On this topic, Samira Hill has provided the country with an important and practical reference point.

### ***Skill Level and Training***

The success of any program or project is usually in direct relation to the people charged with doing the work. While Niger does have some experience with modern mining methods from the uranium and coal operations, Niger has not seen much recent industrial development.

Consequently the availability of experienced engineers, technicians and operators is limited. This situation has a direct impact on the early costs of the operation as the project had to contract short-term, high-priced technical and operating assistance to provide extensive training of the local work force.

Etruscan is committed to maximizing the number of qualified Nigeriens at all levels of the mining operation. The goal is to have the Samira Hill mine staffed and operated largely by a Nigerien work force of skilled locals replacing costly expatriate positions. The commitment is to maximize local hiring as a direct industrial impact, but, more importantly, to empower Nigeriens to take responsibility for the success of the project.

### ***Social Commitments and Community Involvement***

The philosophy of the Company has always been to maintain the highest level of respect for the people of the host country and to identify and assist the practical needs of the impacted population as development proceeds. Helping to meet the basic needs of the local communities is not only the right thing to do, but is a prudent business approach in these underdeveloped countries. Etruscan initiated modest social programs at the very beginning of its exploration activities within Niger.

In the vicinity of the mine site there are many villages hosting several thousand inhabitants. These villages are very primitive with no power, limited sources of clean water and no sewage facilities. Housing comprises mostly of clay brick bancos, which are typically rebuilt after each rainy season. Prior to the Company's involvement, structured health care was virtually nonexistent and the accessibility to education and schooling limited.

The challenge was to demonstrate from the outset the positive impact of the Company's exploration and development activities to avoid any labor or social unrest. There was the direct impact of employment, but it was determined that a broader social impact in the surrounding communities would be necessary during exploration and development to obtain strong local support of the Company's exploration and development activities. This is in contrast to many companies who tend to defer any meaningful local social commitment until a project reaches commercial status and a positive cash flow.

Over the period leading up to commercial production, the Company has supported many local programs and initiatives both on its own and in cooperation with the Nigerien government and local NGOs (non-governmental organizations). These included farming ventures, women in business projects, building of schools and the construction of a regional medical clinic. The support of

these projects has certainly placed the project in good stead, and has helped to avoid any significant labor or civil unrest resulting from the project. Such support is planned to continue over the production phase.

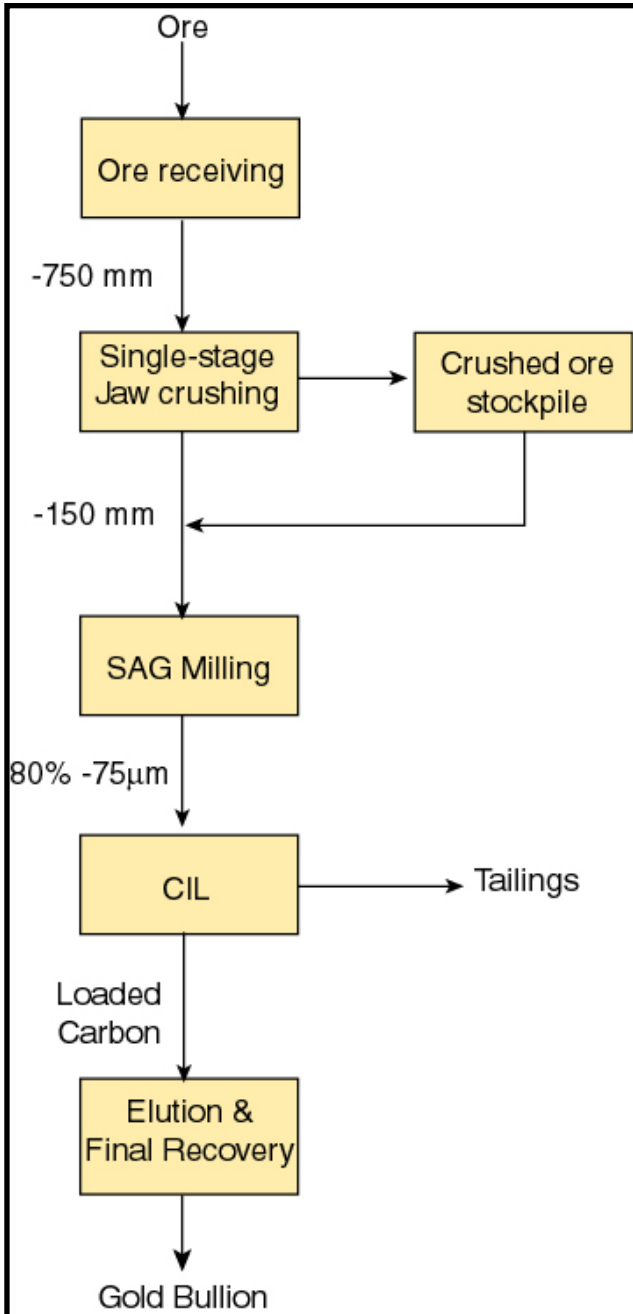


Figure 4. – Simplified block diagram of plant flow sheet

## Conclusion

The exploration and development efforts of Etruscan and Semafo over the past decade have resulted in the construction and operation of the first commercial gold mine in Niger. There were several administrative, social and technical challenges that had to be overcome to realize the successful development of the project. Continued exploration of the Samira Horizon will likely translate into more ore for the Samira plant and perhaps lead to the development of other gold mines in Niger.

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