7. METALLURGICAL AND PROCESSING ASSESSMENT

7.1 General Description of Metallurgical Facilities

For the past 20 years the refractory gold resource at Jinfeng has been metallurgically tested in laboratories in China, Australia, South Africa and the USA. These tests have identified the ultra fine nature of the gold mineralisation within fine sulphides, mainly pyrite and arsenopyrite with minor occurrences in quartz, clays, carbonates and carbonaceous material. There are many similarities to the Carlin Trend deposits in Nevada.

The sulphide level in the ore is low between 1.5%S and 2.5%S. The minerals stibnite, realgar, orpiment and cinnabar are present but there is a lack of base metal sulphides which has precluded the use of concentrate or whole ore roasting techniques as an economic treatment route before conventional cyanidation for gold recovery. Tests have confirmed that autogenous roasting is easily achievable, plus flotation test at SGS Lakefield have confirmed that an 18% sulphur concentrate can be achieved.

The process plant design under construction is based on a metallurgical flowsheet designed to optimise gold recovery and minimise cost of production. The unit operations comprising the flowsheet are all well proven and have been used in the proposed configuration in other successful operations. The route chosen includes primary crushing, semi-autogeneous grinding, ball milling bulk flotation, thickening, biological leaching, and neutralisation, CIL gold dissolution, AARL elution and tailings detoxification.

Tailings from Flotation and Leaching will be impounded in separate storage facilities to avoid biocides returning to the process water circuit.

Where ever possible equipment has been sourced within China, usually for cost reasons. However, all such equipment has a working track record and no equipment is the first of its type and or size.

The prime criteria for the Jinfeng plant design was a capacity 1,200,000 tonnes per annum (tpa) of primary ore with a feed sulphur grade of 1.7% and a maximum grade of 2.25%.

Milling design availability of 91.3% is conservative but within normal levels of modern plants. Design availability of 95% for the BIOX®, CCD, liquor neutralisation, CIL and detoxification circuits is as recommended by Goldfields.

Monitoring of key process streams with essential automated control by Programmable Logic Controllers (PLC's) using a Citect platform is provided to support the plant operations and provide management data.

7.1.1 *Plant*

Subsequent to the preparation of the Project Feasibility Study a further review of the metallurgical data, design criteria and engineering practicalities was completed in the Optimisation Phase Report which resulted in some minor changes to the original flowsheet.

The process route incorporates recovery and blending of ore prior to single stage crushing to a stockpile, underground reclamation and conveying to a single low aspect ratio SAG mill. The discharged pulp is classified by cyclone with the underflow gravitating to the primary ball mill forming a closed circuit.

The cyclone overflow, P_{80} 75 microns, flows to a prefloat stage for graphite/pyrobitumen control.

The prefloat tailings are conditioned and pass to primary flotation and primary concentrate is pumped to a concentrate thickener or to the cleaning circuit. Primary flotation tailings are pumped to secondary grinding and return, P_{80} 38 microns, to two stages of secondary flotation. The secondary flotation tailings are pumped to the tailings thickener. Secondary concentrate is pumped to the three stage cleaning circuit.

Concentrate from the primary cleaner stage is pumped to the concentrate thickener. Concentrates from the second and third stages are pumped to the preceding stage. Cleaner tailings are returned to secondary grinding. After thickening the concentrate is transferred to either of two bio-oxidation surge tanks. Each surge tank feeds a discrete leaching suite comprising four primary leach tanks in parallel which are followed by four secondary leach tanks in series.

Leach residence time of 4.5 days is predicted at a pulp density of 20% weight/weight (w/w) and pH between 1.2 and 1.8 with the pulp temperature controlled at 43°C.

The design of the bioxidation section of the plant has been a separate package by Goldfields/ Gencor using the patented BIOX®, process. A testwork programme was carried out in the SGS Lakefield, Johannesburg, laboratory utilising their 120 litre mini plant for continuous pilot testing. More than 1,000 kilograms of flotation concentrate was produced in a flotation programme in China transported to Lakefield and processed in several campaigns to produce the design and engineering data for the Jinfeng project.

The oxidised pulp from the Biological leaching tanks is pumped to a three stage continuous counter-current decantation thickener circuit for solids liquid separation. CCD thickener over flow is neutralised in six series agitated tanks with thickened flotation tailing to utilise the contained carbonates to a pH of 3.5 and lime to bring the pH to 7 before discharge into the flotation tailings thickener. Soluble arsenic will be precipitated as a stable form of ferric arsenate. CCD thickener underflow is pumped to the pH adjustment tank before further pumping to the six stage CIL circuit with a residence time of 24 hours.

The elution of gold from the loaded carbon is by the AARL system with a 10 tonne capacity elution column. Mercury entrained on carbon entering the elution will be captured in two ways:

- By fume extraction/scrubbing in the carbon regeneration area
- By calcination of electrowinning cell sludge and loaded cathodes condensing mercury vapour generated in the retort/calciner.

Tailings from the CIL circuit is detoxified by the INCO CuSO4 and air/SO2 method (using sodium metabisulphite).

7.1.2 *Test-work methodology*

The chronology of mineralogical and/or metallurgical testwork is shown in Table 7-1.

Table 7-1: Jinfeng Mineralogical and or Metallurgical Testwork Chronology

	Date and Company or Institute
China	March 1989 Changchun Gold Research Institute
	April 1990 Guizhou Province Metallurgical Design and Research Institute
	1991 Changchun Gold Research Institute
Others	1992,1993 Hazen Research Denver Colorado For Davy International
	1995 BHP
	1995 Newmont
	1996 Gencor
	2002 Roger Townend and Associates
	2002 Terry Leach
	2003 Pontifex and Associates
Sino	2001–2003 Channel Samples for Changchun, Ammtec, Lakefield , AMDEL and BGRIMM
	2003 Core samples for variability testing Pontifex AMDEL BGRIMM and Lakefield for BIOX® compatibility

A bulk sample was collected using channel sampling techniques in 2003. This sample was to produce at least one tonne of concentrate for pilot testing of roasting or Biological leaching. The concentrate was prepared at the Beijing General Research Institute of Mining and Metallurgy (BGRIMM).

A suite of lump samples was collected for comminution testing at Amdel's laboratory using the Julius Kruttschnitt Mineral Research Centre (JKMRC) drop testing and Advanced Media competency Testing for mill selection modelling.

The various testwork programmes have established that gravity methods and direct cyanidation were not successful on the Jinfeng ores. Whole ore roasting, whole ore bio oxidation and whole ore pressure oxidation have all been successful metallurgically but have cost implications due to the components the ore or of the offgas and their capture or high acid or reagent considerations. Alkaline pressure oxidation was also not successful.

Concentration by flotation which removed the naturally high carbonate levels of the ore and subsequent concentrate processing offered the best possibility of economic recovery of gold.

Biological leaching of Jinfeng concentrate was demonstrated by Gencor in South Africa and oxidation and CIL gold recoveries of 93% and 94% were achieved.

Comminution testwork has been completed and data generated to facilitate mill selection.

A substantial body of work has been completed to demonstrate the effectiveness of sulphide flotation to concentrate the Jinfeng ores. Two stage grinding and flotation with a primary grind of P_{80} of 75 microns followed by rougher flotation with regrinding of the rougher tailing to a P_{80} of 45 microns and subsequent scavenging in two stages was demonstrated. Cleaning of the primary concentrates with recirculation of cleaner tailings through the secondary ball milling circuit has been shown to provide consistent results and has been adopted for the Jinfeng plant.

In view of the graphite/pyrobitumen content of the ores a prefloat to remove the bulk of the material has been included.

7.1.3 ***Process Engineering Design Criteria***

The process design criteria for the various sections of the plant have been based on extensive testwork with piloting of the process being completed where necessary. The proposed comminution circuits of the Jinfeng ore have been based on data from test samples drawn from channel sampling.

The primary jaw crusher SAG mill, primary and secondary ball mill, and lime slaking mill selected are Chinese in origin with a successful track record.

The flotation circuit and reagent suite has been developed through the work of several laboratories world wide. The circuit has been piloted to prepare concentrate for biological leaching testing. A factor of 200% has been applied to the laboratory residence times in line with normal practice. Flotation equipment chosen is Chinese and has been successfully employed in other successful plants.

The leaching circuit design including biological leaching, CCD circuit and neutralisation criteria have been developed from laboratory and pilot testing through the Goldfields/Gencor/Lakefield BIOX® continuous pilot plant. Engineering design data has been provided by Goldfields based on their experience in design of similar plants worldwide. Data regarding other mines who have or are using BIOX® technology is provided in Table 7-2.

Table 7-2: Sites Using BIOX® Technology

Project Name	Site Location	Commissioning Date	Concentrate Treatment Rate (t/d)	Sulphide Oxidation
Harbour Lights	Western Australia	1991	40	92%
Ashanti	Obuasi, Ghana	1995	960	85% to 90%
Wiluna	Western Australia	1996	158	94%
São Bento	Brazil	1998	120	69%
Tamboraque	San Mateo, Peru	1998	60	80%
Fairview	Baberton, South Africa	1999	55	98%
Olympias	Greece	2005	772	85%
Fosterville	Victoria, Australia	2005	202	98%
Suzdal	Kazakhstan	2005	192	n.a.
Amantaytau	Uzbekistan	2006	1,100	95%
Bogoso	Ghana	2006	822	n.a.
Kokpatas	Uzbekistan	2007	1,069	n.a.
Jinfeng	**China**	**2007**	**790**	**94%**

The CIL and Gold room process design is of typical Australian design with the addition of mercury recovery. Tailings detoxification and liquor neutralization is by well proven and utilized processes.

7.1.4 *Tailings Dams and Water Reticulation*

Tailings from the process plant will be in two parts:

1. The flotation tailings, which comprise the bulk of the solid residues from the plant operations, will be stored in a discrete facility with supernatant liquor being recovered via a decant system at the dam for return to the plant process water system. The flotation tailings will also contain the ferric arsenate precipitated subsequent to the bioleaching of the concentrate. The flotation tailings naturally alkaline with only 5% of the original Sulphide present is expected to remain alkaline to stabilize the arsenic storage

2. The residue from the concentrate processing section of the plant which is submitted to detoxification by the Inco SO2/CuSO4/air process for cyanide destruction will be stored in a separate facility with no return for plant use of the supernatant liquor.

7.2 Process Description

7.2.1 *Crushing*

Ore will be received from the open-pit and underground mines onto the ROM stockpile, where it will be stored in elongated fingers of designated types according to its type. Ore will be reclaimed from the finger stockpiles of the ROM stockpile area by front-end loader into the primary crusher feed hopper. The hopper will be fitted with a stationary 500mm grizzly to prevent oversize from entering the crusher, and with dust suppression sprays. Ore will be withdrawn from the primary crusher feed hopper by an inclined 1,200 x 3,000mm vibrating grizzly feeder at a controlled rate to discharge directly into the primary jaw crusher.

Grizzly fines and crushed ore are collected by conveyor running beneath the crusher which in turn feed the crushed ore stockpile conveyor.

7.2.2 *Milling*

Ore will be continuously withdrawn at a controlled rate, nominally 150 dry tonnes per hour, from the crushed ore stockpile using a combination of a central apron feeder and two in line vibrating feeders each with variable speed drives. The feeder will discharge onto the SAG mill feed conveyor to feed the low aspect ratio SAG mill.

The mill, which is 5.03m diameter by 6.49m effective grinding length, is fitted with a 14mm internal grate between. The mill is driven by a 2.3MW variable speed drive. SAG mill discharge will flow by gravity to the primary cyclone feed sump, where it will be diluted with process water and pumped to the primary cyclones for classification at 75 microns.

Cyclone underflow slurry will be fed to the primary ball mill which is sized to reduce the particle size from an intermediate size P_{80} 367 microns to P_{80} of 75 microns. The ball mill is similarly sized to the SAG mill at 5.03m diameter and 6.79m Effective Grinding Length (EGL) and a 2.3MW drive. Primary ball mill discharge is recycled to the primary cyclones.

Overflow from the primary cyclones will be sampled, passed over a vibrating trash screen to remove detritus and then gravitate to the pre-float section.

7.2.3 *Concentrator*

The overflow from the primary cyclones flows to the pre-flotation circuit. The pulp will be at 20% solids w/w and floated in two 50m^3 cells with MIBC alone as the frother. Testwork has demonstrated that approximately 55% of graphite/pyrobitumen can be removed in this stage. Pre-flotation concentrates will be pumped direct to final flotation concentrate thus lowering the chance that organic carbon could absorb large quantities of flotation reagents.

Pre-flotation tailings will be conditioned with flotation reagents $CuSO_4$, PAX and MIBC, then floated for a total of 18 minutes Primary Flotation residence time in four 40m^3 cells. Concentrate from the first two cells will be pumped to the concentrate thickener, while concentrate from the remaining two cells will be transferred either to final product or to the regrind mill circuit.

The Primary Flotation tailings will be pumped to the secondary cyclones, to cut at 38 microns. Cyclone underflow slurry will gravitate to the secondary ball mill. The size reduction required within the mill is from F_{80} 103 microns to P_{80} 38 microns. The mill is 3.8m in diameter by 6.2m effective grinding length and is powered by a 25MW drive. Secondary ball mill discharge will be recycled to the secondary cyclones.

The overflow from the secondary cyclones will gravitate to a secondary flotation conditioner and six 100m^3 cells. After three cells a conditioner adds the provision to add sodium hydrosulphide to promote flotation. The tailings from the secondary flotation gravitate to a secondary scavenger conditioner prior to secondary scavenger flotation in three 100m^3 cells. After two calls a conditioner adds the provision to add sodium hydrosulphide and PAX to promote flotation.

These long flotation times, representing 200% of the batch laboratory flotation times determined from tests by Australian Metallurgical and Mineral Testing Consultants (AMMTEC), are deemed necessary for high recovery of gold. All secondary flotation concentrates are collected and pumped to the cleaner circuit.

Tailings from the final scavenger flotation stage will be directed to the tailings thickener for water recovery prior to transfer to the flotation tailings dam. The scavenger concentrate and partial rougher concentrate will be pumped to conditioner ahead of a series of six 40m^3 cleaner and cleaner-scavenger flotation cells. The cell configuration as is flexible to allow various cleaner, cleaner scavenger combinations.

The cleaned concentrate prefloat concentrate and partial rougher concentrate will be collected and fed to a thickener for dewatering.

Cleaner tailings will be recycled to the secondary milling circuit cyclones.

7.2.4 *Bacterial Leaching*

Thickened flotation concentrate will be pumped to each of two 800m^3 storage tanks providing a 48 hour surge capacity. Each storage tank feeds a train of four primary leach tanks followed by four leach tanks in series. Stored concentrate will be pumped from the surge tanks to a feed splitter box above the primary BIOX® reactors and dilution water will be injected into the pump discharge line to control the concentrate slurry density feeding the primary BIOX® reactors. The dilution water will be a combination of fresh water sourced from the Luofan River and recycled BIOX® process water.

The splitter box will consist of a timed splitter to evenly distribute the diluted concentrate slurry to the four parallel, 1,000m^3 primary BIOX® reactors. Nutrient solution will be dosed to the feed splitter box to maintain the correct levels of nitrogen (N), potassium (K) and phosphorous (P) in the BIOX® reactors for optimum bacterial activity.

The primary BIOX® reactors will overflow into launders, which will deliver the partially-oxidised concentrate to the first of four, 1,000m^3 secondary BIOX® reactors in series. By-pass launders will enable any one of the reactors to be taken off-line for maintenance. The first secondary reactor can be used as a primary reactor if required.

The BIOX® culture will be kept active in the reactors by controlling the slurry conditions, specifically the temperature, oxygen level and pH, within specific ranges. The oxidation reactions are exothermic and it will be necessary to constantly cool the slurry. Each reactor will be equipped with cooling coil baffles through which cooling water will be circulated to control the slurry temperature at 42°C in each reactor. The circulating water will be cooled through cooling towers to remove the generated heat load. Oxygen requirements for sulphide oxidation are significant and medium pressure air will be injected into each of the reactors by sparge rings installed below the agitator impeller. The slurry pH in each of the reactors will be controlled between 1.0 and 1.6 by the addition of slaked lime slurry from a ring main system.

The oxidised product discharging from the final secondary BIOX® reactor will gravitate via a launder to a three stage counter current decantation solid liquid separation circuit using thickeners.

Spillage from the leaching section and hose-down water will be contained within the section bunded area.

CCD Wash Circuit

During the bio-oxidation of flotation concentrate, iron, sulphur and arsenic are solubilised. The soluble elements will be washed from the oxidised residue in a series of three 15m diameter CCD thickeners. The oxidised residue will gravitate to the feed box of the first CCD thickener, combine with the overflow flowing by gravity from the second CCD thickener.

Flocculant will be added to the feed boxes of all thickeners to flocculate the slurry prior to the feed well of the first CCD thickener to maintain a clear overflow. The overflow solution from the first CCD thickener will gravitate to the neutralization circuit. The underflow from the first CCD thickener will be pumped to the feed tank ahead of the second CCD thickener and similarly for the second thickener to the third. The overflow from the third thickener will gravitate to second thickener feed.

The leaching process water will be used as wash-water in the CCD circuit and will be added to the feed tank ahead of the third CCD thickener.

The underflow from the last CCD thickener is pumped by the thickener underflow pumps to the pH adjustment tank ahead of the CIL circuit.

The iron, sulphur and arsenic will be solubilised during biological oxidation to Fe^{3+} (as ferric sulphate), SO_4^{2-} (as sulphuric acid) and AsO_4^{3-} (as arsenic acid), respectively. The acidic solution will overflow from the first CCD thickener and be pumped to the distribution box above the first and second neutralisation tank.

The neutralisation circuit will consist of six aerated and agitated 300m^3 tanks in series and the solution will flow from tank to tank via overflow launders.

The CCD liquor will be neutralised in two stages. In the first stage flotation tails slurry will be combined with the acidic solution feeding the first tank, utilising the natural basicity of the ore to raise the pH of the solution above pH 3. This allows the natural basicity of the tailings to be used instead of lime reducing costs. In the second step the pH will be raised to between 6 and 8 in the remaining tanks using lime slurry.

Scaling can be expected in the neutralization tanks, due to Gypsum precipitation from lime addition and tanks will be bypassed as required for cleaning and maintenance. The neutralised effluent will be pumped to the flotation tailings thickener.

7.2.5 *Carbon in Leach*

The thickened underflow slurry from the last CCD thickener will be pumped to the pH adjustment tank. Residual acid and any residual soluble arsenic will be neutralized with lime and precipitated as gypsum and ferric arsenate prior to the pumping to the CIL circuit. Sufficient excess lime will be added to raise the pH of the pulp to 10.5. The pH adjustment tank is sized to provide surge capacity between CCD and CIL circuits and sufficient residence time to ensure that there is a delay before the introduction of Cyanide into the CIL circuits.

The pulp with a nominal density of 30 to 35% w/w will be pumped to the distribution box above the first tank of six 430m̊ adsorption tanks in series. The conventional arrangement of interconnected with launders allows the slurry to gravitate through the tanks and tanks to be bypassed as required for screen and agitator maintenance. Dual mechanical agitators and a mechanically swept, woven wire intertank carbon retention screen are used in each tank. A travelling gantry hoist will facilitate the removal of the screens for maintenance and routine cleaning.

Barren carbon will enter the circuit at the final tank and will be advanced counter-current to the slurry flow by pumping using recessed impeller, vertical spindle centrifugal pumps. The counter-current process will be repeated until the first adsorption tank. Loaded carbon and slurry will be recovered from the first tank by recessed impeller pump to a loaded carbon recovery screen. The loaded carbon screen oversize will gravitate to the acid wash column and the screen under flow slurry will return to CIL tank.

The leach tails slurry from the final CIL tank will gravitate to the vibrating carbon safety screen to recover any carbon oversized carbon tanks. The carbon safety screen undersize pulp will gravitate to the tailings detoxification circuit. Sodium cyanide solution will be metered into tanks 1, 2 and 3.

The CIL circuit will operate at high carbon concentration to counteract the preg-robbing capability of the graphite/pyrobitumen present in slurry after the prefloat.

Returned barren carbon and any make up will be screened across a vibrating screen to remove fine carbon before entering the circuit.

7.2.6 *Elution and Electrowinning*

The Elution circuit is a typical AARL circuit using a 10 tonne elution column. It is intended to operate the plant on a five day week basis with one strip per day. There is a separate mercury elution cycle and mercury precipitation circuit.

The loaded carbon recovered on the loaded carbon recovery screen gravitates to the acid wash column and is manually controlled to fill the acid wash column. The acid wash and the pumping sequence will be automated.

During acid washing the dilute solution of hydrochloric acid 3% w/w will be circulated through the column in an upward flow direction to remove contaminants, predominantly carbonates, from the loaded carbon. This improves elution efficiency and prevents the carbonates from reducing the carbon activity after regeneration.

After acid circulation the carbon bed will be rinsed with fresh water. Four bed volumes of low salinity fresh water will be pumped through the column to displace any residual acid from the carbon. The dilute acid and rinse water will be disposed of directly to the tails hopper.

Acid-washed carbon will then be transferred to the elution column from the acid wash tank. After a low temperature cyanide mercury elution, a dilute solution of caustic sodium cyanide will be pumped through the column to elute the gold and silver from the carbon.

The solution is heated through a heat exchanger and initially through a recuperative heat exchanger to maintain the strip solution at approximately 125°C.

A circulation time of less than one hour will be sufficient to complete the elution. The column will then be flushed with fresh heated water pumped into the base of the column. The eluate and fresh water will be cooled through the recuperative heat exchanger pre-heating the incoming solution. The eluate will be circulated by pump to electrowin both gold and silver from solution. This will be accomplished in three electrowinning cells in parallel. Each electrowinning cell has 12 cathodes.

The electrowinning cycle will continue until the solution exiting the electrowinning cells is depleted of gold and silver values. After completion of the elution process, the barren carbon will be transferred from the elution column dewatered and fed to a horizontal carbon regeneration kiln. The carbon will be heated to 650 to 750°C for re-generation.

Regenerated carbon exiting the kiln is water quenched and then sized on a screen to remove fine carbon. The screen oversize will return to the CIL circuit and the undersize will be discarded.

Mercury which enters the circuit via the loaded carbon and is not eluted will be volatilised in the regeneration kiln. An extraction scrubber will capture the emission for the regeneration kiln and surrounding area. The cell cathodes will be stainless steel wool. The loaded cathodes and cell sludge will be recovered and calcined before smelting.

The calcining oven will remove and capture mercury by volatilization. The calcined residue will then be direct smelted with fluxes in a diesel-fired furnace to produce doré bullion.

The tailings from the final CIL tank will be passed through a safety screen to capture any coarse carbon that has become entrained. The carbon safety screen underflow will gravitate to the feed distribution box ahead two agitated, aerated interconnected tanks in series.

Sodium metabisulphite and copper sulphate will be added into the feed distribution box to destroy free and weak acid dissociable (WAD) cyanides present. Lime is also added to provide protective alkalinity and the pH is maintained at 10. The resultant effluent will be pumped to the CIL residue storage facility at a total WAD cyanide (CN) of less than $0.5 g/m^3$. In order to control any heavy metal sulphides sodium hydrosulphide will be added to precipitate sulphides.

7.2.7 *Plant Services*

Water

Water for the plant will be pumped from the Luofan river adjacent to the mine site to the Raw Water tank for distribution to process water, fire water, camp water treatment etc. Where possible water is reclaimed within the plant before exiting in the plant tailings. The flotation tailings supernatant water will be recovered by decantation and returned to the process water system. The water from the CIL tailings impoundment will not be recycled to the plant due to biocides such as thiocyanates present from the BIOX® plant.

Compressed Air

Compressed plant and instrument air will be supplied at a pressure of 700kPa. The instrument air will be dried via a refrigerated air dryer. Plant air and instrument air will be reticulated throughout. Centrifugal blowers will supply medium pressure air at 120kPag which will be reticulated throughout the leaching neutralisation, CIL and tails detoxification circuits with off-takes at each tank.

Power

The site power is nominated as a grid connected 1 x 20MVA 110/6.3kV power transformer connection. Sino advised that there is provision for a second transformer to be added. The standby power 1 x 1200kW of emergency diesel generators will be installed at the BIOX® plant 6.3kV substation. The standby power will facilitate the maintenance of a viable culture in a minimum of one primary reactor.

Process Control Philosophy

The overall control philosophy is to provide sufficient automation and instrumentation to assist the operators in monitoring and controlling the plant in order to maximize production and production efficiency. The functionality of the proposed system is provided by the three tier pyramid network.

The bottom tier comprises field devices, switches contactors etc. The second tier consists of software configurable and programmable hardware (PLC's) which will implement sequence logic program and proportional integral derivative (PID) algorithms.

The top tier, the overlying control system, will be a SCADA-type Citect system. These systems and their components are robust and proven and currently in use throughout the gold industry and provide a reliable mid level of automation.

The sensors proposed are reliable and well proven. The number of operator interface terminals is typical of this type of plant.

7.3 Forecast Metallurgical Performance

7.3.1 *Throughput*

The design throughput of the Jinfeng plant is 1.2Mtpa ore. This will be achieved using the crushing plant for 3,285 hours per annum, the milling circuit for 8,000 hours per annum at 91.3% availability and the BIOX®, CCD, liquor neutralisation, CIL and detoxification circuits for 8,320 hours per annum at an availability of 95%.

The bioleaching section has the capacity to oxidise 74t of sulphur per day with the expected mean daily sulphur intake being 65.8t which equates to a daily throughput of 790t of concentrate at a grade of 8.32%S.

7.3.2 *Head Grade*

The plant gold head grade is expected to be 5.9g/t Au with a range of 5.5 to 6.3g/t Au. The plant sulphur head grade for flotation design purposes is 1.57%.

7.3.3 *Tails Grade*

It is anticipated that gold tailings grades will vary between 0.4 and 0.7g/t depending on the plant head grade. For sulphur tailings grades will similarly vary between 0.1 and 0.2%S.

7.3.4 *Concentrate Grade and Sulphur Grade*

Gold values for flotation concentrate are expected to range between 25 and 35g/t and will obviously depend on the mass pull to concentrate which for design purposes has been calculated at 22.8% but will range between 14 and 23%. Similarly for sulphur a design value of 10% has been used with a range of 8.3 to 12.5%.

In terms of mass of concentrate that the bioleach section can accommodate this will equate to 790t/day for a sulphur grade of 8.3% and 526t/day for a concentrate with a 12.5% sulphur grade.

7.3.5 *Deleterious Elements in Concentrates*

The presence of the sulphide minerals stibnite, realgar, orpiment cinnabar plus native arsenic in the Jinfeng ore means that after concentrating in the flotation section these minerals have the possibility of solubilising in the bioleaching.

In the case of mercury the values in Table 7-3 are predicted from laboratory testwork or by predictions from technical literature.

Table 7-3: Process Behaviour of Mercury

Grade in ore	133g/t
Recovery into Concentrate	94%
Solubilised in BIOX®	2%
Solubilised in CIL	2–4%
Absorbed onto Carbon	95%
Eluted from the Loaded Carbon	80%
Recovered in Calcine oven	99.9%
Volatilised in the Furnace	99%
Volatilised in the Regeneration Kiln	100%
Precipitated in Detox	99%

Arsenic in the form of arsenopyrite, realgar and orpiment will be recovered to the flotation concentrate and the arsenic is solubilised in the bioxidation process.

The iron to arsenic ratio dictates the stability of the arsenic precipitates formed on neutralization of the leaching waste liquor. Providing the molar ratio of iron to arsenic in a concentrate is greater than 3 ensures a stable ferric arsenate is formed. For Jinfeng, the ratio of iron to arsenic in the concentrate is expected to be >8 and environmentally acceptable effluents are expected.

The Jinfeng concentrate contains relatively low antimony and no toxicity effect from antimony is foreseen.

Lead sulphide minerals forms insoluble PbSO4 during bioxidation. Levels in Jinfeng ores are low and should not cause process problems. Goldfields recommend lead concentration in solution should be occasional monitored to give an early warning of a threat to bacterial activity.

7.3.6 *Metallurgical Recoveries*

The designed plant recoveries are as follows:

- Flotation — Sulphur recovery — 95% into concentrate
- CIL — Gold recovery — 93.1% from concentrate
- CIL — Silver recovery — 80% from concentrate

7.3.7 *Plant Maintenance Philosophy and Procedures*

The plant has been designed to operate at normal availabilities for plants of this type throughout the world. The plant layout is designed with maintenance in mind and facilitates crane access for major equipment. Critical items of equipment such as pumps are provided with standby facilities.

Tanks have launders and connection systems which facilitate individual equipment isolation for repair without total process interruption.

Similarly in the event of power interruption there is sufficient power available to sustain the materials in process until full power is restored allowing resumption of feed.

7.3.8 *Housekeeping*

The plant has been designed with normal "Western" style access and plant sections and circuits are contained in spillage recoverable wash down areas.

7.4 Forecast Reagent Consumption

The forecast reagent consumption for the Jinfeng flotation plant is shown in Table 7-4, for the Bioleach plant in Table 7-5 and for the CIL plant in Table 7-6.

Table 7-4: Forecast Reagent Consumption — Jinfeng Flotation Plant

Reagent	Reagent Consumption in kg/t of ore processed
Copper sulphate	0.80
Sodium Hydrosulphide	0.65
Potassium amyl xanthate	0.72
Frother (MIBC)	0.28
NaHS	0.04
Carbon collector	0.03
Flocculant	0.03

Table 7-5: Forecast Reagent Consumption — Jinfeng Bioleaching Plant

Reagent	Reagent Consumption in kg/t of ore processed
Lime Addition	67kg/t
Acid Addition	15kg/t
Nitrogen	1.00kg/t
Phosphorus	0.20kg/t
Potassium	0.50kg/t
CCD Flocculant	0.13kg/t
CCD Lime Neutralisation	82kg/t

Table 7-6: Forecast Reagent Consumption — Jinfeng CIL Plant

Reagent	Reagent Consumption in kg/t of concentrate produced
NaCN	12kg/t
Activated carbon	20g/litre
HCl	Batch
NaOH	Batch
NaHS	0.05kg/t
Lime	10kg/t

7.5 On-site Assay Laboratory Standards

The onsite assay laboratory will be built and operated to world standard and the onsite metallurgical laboratory will be fully equipped for routine metallurgical tests including flotation.

7.6 Metallurgical Sampling and Accounting

The planned sampling regime is to world standard and facilitates full metallurgical accounting of ore treated.

7.7 Throughput Expansion Potential

During the design phase and optimization study the engineer gave thought to the possibility of increasing the plant throughput by 50%. The crushing capacity is adequate for the expanded rate. The milling capacity will have to be increased by adding a second primary ball mill and possibly a second secondary ball mill. Real Estate is available to facilitate the expansion. The flotation capacity will have to be increased and is allowed for in the plant layout. Thickener design for concentrate and tailings have large safety factors and should accommodate 50% expansion. However real estate is available for additional units. BIOX® capacity is based on sulphur oxidation capacity. A third train can be accommodated in the area. The possibility exists that with knowledge of the plant operation the existing two train leaching section could cope with a 50% expansion if flotation concentrate quality is modified. CCD thickeners as other units have a safety factor that may allow the processing of the expansion. Real estate exists for the installation of a second train. Neutralisation capacity will have to increase and this can be accommodated within the current plant footprint.

The CIL circuit designed on residence time has the capacity to allow the 50% expansion and the elution system is based on a 5 strip per week regime which can be increased to cope with the expansion. Tailings disposal will have to be improved to accommodate a 50% increase in throughput. Reagent Mixing can adequately cope with the expansion.

Utilities such as power, electrical services, air systems and water cooling will have to be expanded to facilitate plant expansion.

7.8 Construction Status

At the time of SRK's site visit in October 2006, it was forecast by Sino that sulphide ore processing could commence in the first quarter of 2007 and that the full plant would be operational by March 2007.

8. MAJOR CONTRACTS

8.1 Jinfeng BIOX® Licence Agreement and Process Guarantee

Sino entered into an agreement with Minsaco BIOX® Pty Limited ("Minsaco") on 23 June 2004. Minsaco is a wholly-owned subsidiary of Gold Fields Limited, a company listed on the Johannesburg stock exchange. Under the agreement Sino has agreed to engage Minsaco to provide to Sino a licence to use the BIOX® process in the Jinfeng processing plant, a process design package, consulting services, design certification, inoculum, ongoing and updated information, improvements and developments on the BIOX® Process and plant commissioning and training.

The agreement with Minsaco provides a "guaranteed" minimum percentage pyritic sulphur removal from Jinfeng Material of 94% from "Concentrate of Feedstock Quality". This performance is based on 95% availability of the plant and a throughput of 65.8 tonnes of sulphide sulphur per day. The agreement defines the chemical quality of the material which Minsaco guarantees will be processed and defines the maximum acceptable levels of trace elements.

Gold Fields Limited has provided Sino with a letter of support in relation to the Jinfeng BIOX® agreement, in which Gold Fields commits to provide Minsaco with sufficient technical and human resources support "to ensure that Minsaco performs its obligations and meets its liabilities under the licence agreement".

8.2 Mining Contract

Sino has entered into a contract with No.19 China Railway & Construction Company for the open-pit mining at Jinfeng. The contractor has taken delivery of a fleet of new Komatsu equipment, including three PC1250 Excavators, twenty HD605 65t Dump Trucks, a dozer, water truck and a grader.

Drilling and blasting: Sino has appointed Guizhou Construction Company as the drilling contractor for Jinfeng. The contractor will utilise three new Atlas Copco L8 drill rigs to complete all drilling for mining purposes.

Explosives will be supplied under contract but placement of the explosives in the drill holes will be completed by Sino employees. SRK endorses this method as it allows Sino to control a critical component of the mining process.

8.3 Supply Agreements

8.3.1 *Electrical Power and Water Supply*

Sino has agreed a Combined Infrastructure Deal which was negotiated with the County. For electrical power supply, the 110KV line connected to the Provincial electrical grid has been extended 42km from Zhenfeng. The forecast demand from the Jinfeng site is approximately 22MW. A backup 3MW diesel set is on site to provide power if the grid connection is interrupted. Electrical power cost for the Jinfeng site is forecast by Sino at US$0.05 per KWHr.

Water requirements are estimated at 7,200m^3/day which will be sourced from the Luofan River and pumped to the process plant via a 3km pipeline.

8.3.2 *Diesel Fuel Supply*

Diesel fuel will be supplied to the Jinfeng site by road tanker and is part of the open-pit mining contract. Sino will purchase diesel from the open-pit contract as required for any underground mine equipment which is powered by diesel engines.

8.3.3 *Explosives Supply*

Sino has awarded the explosives supply contract to Chongqing Gezhoubal Explosive Chemical Company Limited (EXPL) who have considerable experience at the Three Gorges Dam project. EXPL have built a production plant on site. EXPL will supply both Ammonium Nitrate-fuel oil (ANFO) and emulsion explosives. Sino have also made arrangements to be supplied with Orica detonators and other blasting accessories.

9. ORGANISATION CHART AND WORKFORCE

9.1 Organisation Chart

Sino has a quite flat organisational structure as shown by the organisation chart depicted in Figure 9-1. The General Manager has ten department managers reporting to him, with each department responsible for a defined component of the site functions.

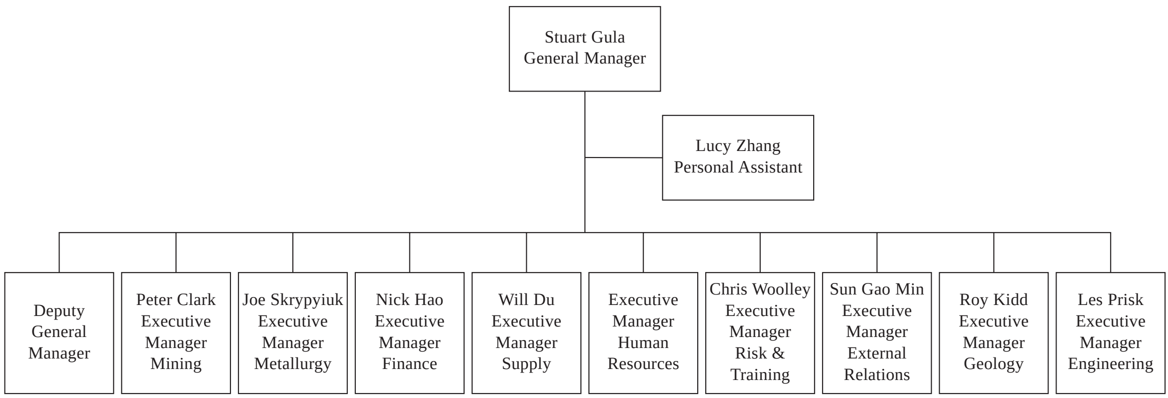


Figure 9-1: Sino Organisation Chart as at November 2006

9.2 Planned Total Employees

The forecast workforce throughout 2007 is shown in Table 9-1.

Table 9-1: Forecast Workforce Numbers

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SUMMARY (JF EMPLOYEE ONLY)												
GM	7	7	7	7	7	7	7	7	7	7	7	7
SUPPLY	36	36	40	42	43	43	43	43	43	43	43	43
CATERING	3	3	3	3	3	3	4	4	4	4	4	4
SAFETY	13	13	13	13	13	13	13	13	13	13	13	13
CLINIC												
C/ RELATION — SITE	10	10	11	11	11	11	11	11	11	11	11	11
TRAINING	23	23	23	22	22	22	22	22	22	22	22	22
FINANCE	11	11	11	12	13	13	13	13	13	13	13	13
H/RESOURCE	6	6	6	6	6	6	6	6	6	6	6	6
E/RELATION — GUIYANG	7	7	7	7	7	7	7	7	7	7	7	7
ENVIRONMENT	13	13	13	13	13	13	13	13	13	13	13	13
SECURITY	3	3	3	3	3	3	3	3	3	3	3	3
MINING	37	37	39	39	39	40	40	40	40	40	40	40
MINE GEOLOGY	42	43	43	43	43	43	43	43	43	43	43	43
PROCESSING	87	101	101	101	101	101	101	101	101	101	101	101
ENGINEERING	91	101	118	114	118	123	131	139	141	151	153	153
TOTAL	389	414	438	436	442	448	457	465	467	477	479	479
EXPAT/NATIONAL												
EXPAT	11	11	11	10	10	10	10	10	10	10	10	10
NATIONAL	378	403	427	426	432	438	447	455	457	467	469	469
TOTAL	389	414	438	436	442	448	457	465	467	477	479	479

SRK notes that the percentage of expatriate workers is less than 3%, so that 97% of the workforce is intended to be Chinese. Sino has a target that 50% of the employees will be drawn from the local area and proposes to give preference to workers from Guizhou Province.

9.3 Assessment of Local Labour Force

China has a well established mining contractor skill base. The mining contractor at Jinfeng has experience at a wide range of civil construction and earthmoving projects and is a subsidiary of one of the top ranking construction companies in China. The underground mining workforce will be based around experience underground miners from Sino's previous mine at Jinchialing. The process plant operators will be drawn from a range of reasonable well experienced workers, many of whom have qualifications in chemical engineering and metallurgy. There are few operators in China with experience in BIOX® but the skills will initially be provided by expatriates who will provide training to the Chinese employees. Maintenance skills are readily available in China, as are administrative and accounting skills.

10. SAFETY

10.1 Historical Safety Records

Sino has established a strong safety culture on site during the exploration and construction period. The following table shows a very low number of lost time injuries and a low Lost Time Injury Frequency Rate. The Medical Treated Injury Frequency Rate and the Significant Incident Frequency Rate are also both quite low considering the number of manhours worked. It is commendable that both the Sino employees and those of the Engineering, Procurement and Construction Manager (EPCM) contractor are demonstrating a strong safety performance.

Table 10-1: Jinfeng Safety Performance Statistics

	Total Project	EPCM Project
Manhours Worked	3,923,865	1,652,697
Lost Time Injuries	4	1
Lost Time Injury Frequency Rate	1.0	0.6
Medical Treated Injury Frequency Rate	5.9	n.a.
Significant Incident Frequency Rate	4.9	n.a.

10.2 Safety Procedures and Monitoring

Occupational health protective equipment and clothing generally appears to be available and is being enforced for all Sino employees. Safety provisions for surface plant, such as unsafe areas being clearly demarcated, moving machinery parts being appropriately guarded, and guard railings are being installed on all gantries. The site has a safety induction system for site visitors and new employees, and trained emergency response teams are maintained on-site.

During operations a work permit system will be establish that will assist in the control of health, safety and environment (HSE) hazards and risks for some higher risks activities or where there is not a recognised work procedure or where non routine dangerous equipment is being used. The permit system will also ensure that potential hazards are communicated to the appropriate personnel.

The project is committed to providing quality personal protective equipment (PPE) for use when other measures fail to control risks adequately. Areas and tasks will be reviewed to identify their PPE requirements and mechanisms will be in place to approve all PPE and to ensure that only approved PPE is purchased. Signs will be placed in areas to alert people to the PPE requirements.

Sino has committed establishing HSE monitoring programs to address legal requirements and sampling methods. The programs will cover the following areas:

- Environment Monitoring:
  - — Air emissions, stacks and vents
  - — Air emissions, ambient air
  - — Water sampling, surface
  - — Water sampling, potable water

  - Water Sampling, underground
  - Water sampling, tailings dams (CIL and Flotation)
  - Water discharges, CIL tailings dam and sedimentation dam
  - Process liquids
  - Noise, facility boundaries

- Occupational Hygiene Monitoring:
  - Air emission, underground and surface wherever dust, fumes, vapours are generated
  - Noise, occupational exposures
  - Noise, machinery and equipment as identified.

- Health Monitoring:
  - Pre-employment medicals
  - Health checks for blood pressure, heart, lung, blood, abdomen and liver.
  - Mercury and arsenic levels in blood
  - Lung function
  - Hearing

11. OPERATING AND CAPITAL COSTS

11.1 Operating Costs — Forecast

Sino's forecast of average Life of Mine (LOM) operating costs, based on average gold production, is approximately US$220/oz of gold produced. Variations can be expected during shorter time periods, as both operating costs and gold production may vary during that period.

11.2 Capital Costs — Forecast

In August 2005 Sino issued a forecast capital cost of US$70 million (M) for the Jinfeng project to achieve first gold production. Due to changes in equipment and a delay in completion of the construction phase, Sino forecast in October 2006 that the capital costs was expected to be in the range of US$90 to US$95M.

The pre-production capital cost of the Jinfeng underground mine has been forecast by Sino at US$20M to achieve the first underground ore production by the first quarter of 2008. Sino has estimated the total capital costs for the underground mine, as shown in the following table.

Table 11-1: Sino's Forecast of Jinfeng Underground Mine Capital Cost

Capital Items	US$M
Decline and portal	3.7
Horizontal development	0.9
Shafts	3.8
UG communication & substations	2.3
Mine services	0.3
Mobile equipment	13.7
Ventilation	1.0
Mine main substation	0.3
Backfill plant & UG fill pipelines	1.9
Capitalized UG Mining Admin	1.9
UG EPCM	0.7
UG contingency	2.8
Purchase of JCL equipment	0.9
Total Underground Mine Capital	**34.1**

As described in the Environmental section of this report, SRK has identified that a capital costs in the range of US$18 to US$20M may be required for ongoing rehabilitation and eventual closure of the site.

12. INFRASTRUCTURE

12.1 Road Access

The Jinfeng mine is connected to the Provincial road system. From Guiyang, the capital city of Guizhou Province, a sealed four lane highway is in construction to connect to Kunming, the capital city of Yunnan Province. In October 2006 this highway was completed to Huangguoshu where a major suspension bridge is being constructed to span the gorge. When completed this bridge will make a significant reduction in the travel distance and time required to drive to Jinfeng. From Zhenfeng county town (Mingu) the road to Jinfeng reverts to 43km of unsealed road through the mountainous region. Sino has constructed 12km of sealed access road to Chinese Class 4 standard from Wei Li to the mine site entrance. The County has recently agreed to seal the remaining 43km section of the access road.

12.2 Accommodation

At the Jinfeng minesite, Sino has constructed housing units for managers and senior staff and terrace units for the bulk of the workforce. Sino's aim is for 50% of the workforce to be locals who commute daily by bus from their village or town. In October 2006 the Jinfeng camp included workers from Ausenco Limited, the Australian company who is managing the construction of the process plant. The camp included a kitchen and dining room serving both Chinese and western food. The camp has a nominal capacity of 250 persons but due to the volume of construction activity was accommodating 340 workers in October 2006. New accommodation and kitchen facilities are expected to relieve the accommodation shortage during the fourth quarter of 2006 and to provide facilities for the operational workforce.

12.3 Electrical Power

The 110kV line connected to the Provincial electrical grid has been extended 42km from Zhenfeng. The forecast demand from the Jinfeng site is approximately 22MW. A backup 1.2MW diesel set is on site to provide power if the grid connection is interrupted. Electrical power cost for the Jinfeng site is forecast by Sino at US$0.05 per KWHr. Sino expressed some concern that the local power authority may not be able to meet the full demand of the region if several other future users come on line. The problem has been partly resolved by adding an extra feeder (currently in construction) in the first segment of the supply line to Xingren which reduces the impact of the overloading at the far end of the feeder, near the generation plants. In the longer term Sino has agitated for an additional feeder line to be constructed from Ceheng. The capital cost of such a project is estimated at 6M RMB (US$800,000) to construct approximately 22km line plus a breaker and other switching equipment at Ceheng. The line design has been completed and the construction time is estimated at 3 months. Sino has made a contingency provision in the 2007 Capital Budget for this expenditure.

12.4 Water Supply and Reticulation

Water requirements are estimated at 7,200m^3/day which will be sourced from the Luofan River and pumped to the process plant via a 3km pipeline.

The Datian hydroelectric scheme normally draws water from upstream Luofan and discharges it into Beipan River, bypassing Jinfeng's raw water extraction point. The Datian scheme has a regulatory requirement to control draw-off so that a minimum residual flow in the Luofan River of 1,300L/s is always maintained which easily exceeds Jinfeng's required take-off volume. There is a slight possibility that the Datian scheme may ignore the regulation and draw off more water for power generation and leave Jinfeng with insufficient water flow. Sino has studied several alternatives, including 1) a very large aquifer under the Laizishan limestone dome which can be accessed from shallow bores and 2) the Beipan River is about 6km from Jinfeng and some water supply may be available. Flows in the Beipan River are 20-50 times those in the Luofan River. SRK believes Sino has made adequate provisions to ensure a reliable and sufficient water is available to the project.

12.5 Diesel Fuel

Diesel fuel will be supplied to the Jinfeng site by road tankers which will pump supplies of diesel fuel into storage tank onsite.

12.6 Explosives Handling and Storage

A secure storage magazine for explosives has been constructed several kilometres from the mine. The location is removed from site activities and is accessed from the road to the tailing storage facilities.

12.7 Workshop Facilities

The workshop for maintenance of mining equipment has been constructed and is being used to assemble the mining equipment fleet. Workshops are also currently located within temporary facilities adjacent to the processing plant which is under construction.

12.8 Transport

Jinfeng has adequate road transport facilities to allow completion of the site construction and to supply the needs of the mine once it is operational. The County has recently agreed to seal the remaining 72km section of the access road.

13 ENVIRONMENTAL ASSESSMENT

13.1 Commitment to Protecting the Environment

Sino has committed to meet or exceed Health Safety and Environment performance standards as required by:

- Chinese legislation and standards
- International standards and codes of the mining industry and as indicated by applicable policies and guidelines of the International Finance Corporation
- Sino Corporate Policies

To ensure that IFC requirements will be met, an independent third party review of the Sino project proposal and ESIA was commissioned (Golder, 2006). The ESIA provides a description of the proposed project and identifies potential social and environmental impacts.

A number of issues were identified in the initial third party assessment and as a result Sino agreed to a number of additional commitments to improve the environmental management and monitoring of the project. These additional commitments included completing:

- An Environmental Action Plan (EAP)
- An Acid rock Drainage Management Plan
- A Hazardous Substances Management Plan
- A Water Management Plan
- An Emergency Management Plan
- Panel Review of Tailings Dams

Sino also agreed to completing biannual audits of compliance, health, safety and environment management system and that these audits would be completed by an appropriately qualified independent auditor.

The management of the CIL tailings impoundment water has been identified as a critical compliance issue and that uncontrolled and untreated discharge from this facility has the potential to significantly impact the receiving water quality in the Luofan River. To this end Sino has stated that prior to any discharge, the water will be tested for conformance with regulations regarding WAD cyanide and toxic metals. In the event that the water does not meet discharge criteria, the Environmental Manager will report any exceedances to the Plant Manager and the Plant Manager will have the responsibility for determining the action to be undertaken, such as halting CIL discharges. SGJM has also committed to the construction of water treatment plants at Jinfeng that if designed, built, operated, serviced and managed correctly, should substantially reduce the likelihood of exceeding licence conditions for the operation.

In general, as indicated by the third party reviewers, Sino has satisfactorily addressed all the issues identified to meet the IFC requirements. It is noted however that a soil balance has not yet been prepared for the project. Nonetheless Sino has demonstrated a commitment to protecting the environment and submitted to implementing environmental management and monitoring strategies that are expected to achieve the goals and standards to which Sino subscribes.

SRK however identified a number of issues and concerns that may represent operational and closure risks. These are discussed below under environmental risks.

13.2 Licensing and Compliance Conditions

SRK viewed the necessary construction certificates for all areas of the site which are in order. Operating and environmental permits will be issued once the plant has been operational for three months and the project has been shown to be operating within the predicted impacts presented in the EIA.

It is our understanding that Sino has adopted the following pH and concentration limits for discharges from the CIL TSF into the Luofan River:

- 6 to 9 pH
- 0.1 milligrams/litre (mg/l) free cyanide (World Bank)
- 0.5mg/l WAD cyanide (World Bank)
- 0.5mg/l total cyanide (Chinese Standard GB8978-1996 applying to Jinfeng Project)
- 0.5mg/l total arsenic (Chinese Standard GB8978-1996 applying to Jinfeng Project)
- 0.1mg/l total cadmium (Chinese Standard GB8978-1996 applying to Jinfeng Project)
- 0.05mg/l total mercury (Chinese Standard GB8978-1996 applying to Jinfeng Project)
- 0.5mg/l total copper (Chinese Standard GB8978-1996 applying to Jinfeng Project)
- 1mg/l total lead (Chinese Standard GB8978-1996 applying to Jinfeng Project)
- 2mg/l total zinc (Chinese Standard GB8978-1996 applying to Jinfeng Project)
- 2mg/l total manganese (Chinese Standard GB8978-1996 applying to Jinfeng Project)
- 2mg/l total iron (World Bank)
- 15mg/l ammonia-N (Chinese Standard GB8978-1996 applying to Jinfeng Project)

It is also our understanding that Sino has committed to meeting Chinese National Class III receiving water standards. Standard concentration limits for sulphate, nitrate, iron, thallium and manganese in Drinking Water Quality Standard at Concentrative Surface Water Source (GB3838-2002) are used. Fecal coliform, TDS and total hardness concentration limits set in Sanitary Standard for Drinking Water (GB5749-85) are used.

Based on the available dilution within the Luofan River it is expected that should the discharge standards be met, that the receiving water quality objectives will likely be achieved.

Chinese air quality standards (GB3095-1996 class 2 and TJ36-79 residential region for arsenic) are to be applied to the site. It is anticipated these are likely to be met based on the proposed mitigative measures.

Significantly, Sino is committed to a zero discharge policy. While this will not be possible during the early stages of operations, Sino is looking toward developing a water treatment processes to allow total water recycle to the plant. The anticipated target for introduction of these processes is 1–2 years

13.3 Environmental Risks

The issues and concerns identified by SRK that are considered to remain potential environmental risks, or may impact on the ability of Sino to operate the processing plant uninterrupted include:

- CIL Tailings Facility Water Management
- Waste Rock Characterization, Metal Leachability and Water Management Strategy
- Co-disposal of process treatment solids with flotation tailings
- Soil Balance and Closure

The following subsections briefly summarise these issues.

13.3.1 *CIL Tailings Water Management*

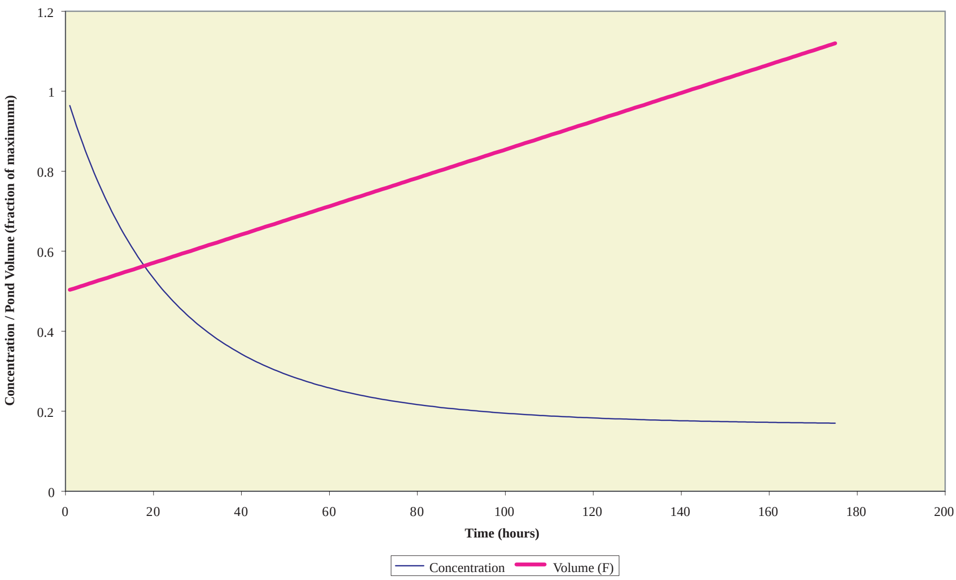
As noted previously, should the proposed effluent standards be achieved it is likely that potential impacts from the treated CIL discharge is likely to be acceptable. We note that Sino has consistently operated its cyanide destruction plant at its other gold mine at Jianchaling to achieve 0.3–0.5 ppm for a 8 year period. Testing to date however has indicated that the BIOX® CIL tailings response may be different to conventional CIL tailings. Also, the effectiveness of the proposed polishing treatment strategy has not been demonstrated.

While the proposed polishing treatment processes (i.e. peroxide with copper catalyst, ferric chloride co-precipitation and neutralization) have not been fully demonstrated for the CIL tailings water, it is considered that some combination of unit treatment operations will likely achieve concentrations within the effluent discharge limits. However, the proposed treatment strategy to recycle water to the CIL pond poses a high risk.

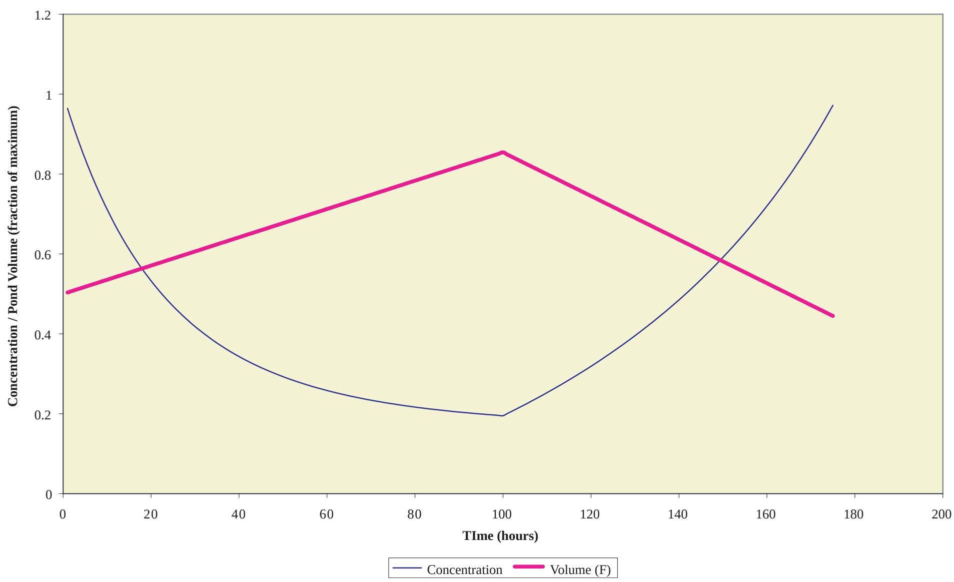
First, we note that the proposed treatment process does not include a unit operation to remove the precipitates that will be formed; rather it is assumed that the solids will settle from solution within the pond. When the combined effects of the suspended solids generated within the recycle and that contained in the treated CIL discharge to the pond are considered it is unlikely that sufficient retention time will be available to allow effective settling, especially when the size of the pond diminishes during discharge to the Luofan River. There is therefore a high risk that elevated loadings of suspended solids will be released. The suspended solids will be characterized by elevated metals which may preclude achieving discharge limits and will pose a risk to the receiving environment.

Second, we believe the pond dynamics and the concentration reduction that may be achieved with a proposed 100L/s recycle rate has been underestimated. To illustrate this, a series of calculations have been completed with the simplifying assumption that the net inflow during the average dry season enters at a unit concentration. It is further assumed that treatment commences when the pond contains 10,000m^3 of supernatant (i.e. at 50% of its maximum allowable volume), also at unit concentration. The recycle is assumed to be at 100lL/s, and it is assumed that the treatment step removes 100% of the contaminant (i.e. the concentration in the treated recycle is zero). As illustrated in the first diagram (a) shown in Figure 13-1, the concentration in the pond will decrease over time while the pond fills. Once the pond reaches the maximum capacity in about 140 hours or about 5.8 days (i.e. when the CIL may be shut down if the concentration limits are exceeded), the concentration will only be about 20% of the initial concentration. Even if the initial pond was at zero concentration, the concentration in the pond will increase over time to be asymptotic at about 18% of the influent concentration. This means that, for example, to achieve the discharge limit of 0.5mg/l for total cyanide (CN-T), the maximum CN-T concentration in the influent cannot be higher than about 2.9.

The next diagram (b) in Figure 13-1 illustrates the effect on pond volume and contaminant concentration should discharge commences (at the proposed 4,000m^3/day) and treatment ceases at 100 hours (4 days) when the pond reaches 85% of the maximum capacity and the concentration in pond had decreased to the 20% of the initial concentration. The immediate effect, due to ongoing CIL tailings inflow to the pond is that the concentration increases while the pond level drops. Since the pond size diminishes the concentration increases more rapidly. By the time the pond has decreased to 50% of capacity, the concentration in the pond is at about 80% of the influent concentration. The risk that the proposed strategy will lead to exceedances of effluent limits is high and will likely lead to operational stoppages based on Sino's current commitments. It is likely that continuous treatment will be required rather than intermittent, and the proposed frequency of discharge may not be possible. Furthermore, it will be necessary to revise the proposed monitoring frequency to correspond to actual performance.



(a) 100L/s treated recycle; complete removal of contaminant; pond volume shown as a fraction of maximum



(b) Discharge commences after 100 hours of recycle at 4000 m^3/day

Figure 13-1(a)/(b): Dynamics of Proposed CIL Pond Treatment Strategy on Pond Volume and Concentration

It is further noted that the proposed operating strategy for tailings deposition in the CIL tailings facility is not likely to facilitate meeting the treatment discharge concentration limits for the following reasons:

- The proposed CIL tailings treatment strategy prior to deposition includes the precipitation of some metals as metal sulphides using sodium hydro-sulphide (NaHS). These secondary metal sulphides will form as small particles which will have a large surface area, and it is expected that exposure to oxygen (on the beaches) will lead to the rapid oxidation of these phases with the resultant increase in dissolved metal loading to the pond. (We note that weathering tests have not been completed on these tailings.)

- The tailings have been shown to be net acid generating. While in excess of 94% oxidation is guaranteed by Gold Fields for the BIOX® process, the CIL tailings are expected to have a residual sulphide content of about 0.5 to 1 % (estimated acid generation potential of 15 to 30kg H_2SO_4/tonne) with no neutralization buffering capacity since they have been acid leached. Extended exposure of the tailings, as proposed by the beach deposition strategy, could lead to the oxidation of the tailings, acidification and increase metal release to the pond.

In both cases, the appropriate mitigative measure would be sub-aqueous disposal, however, that may inhibit densification of the tailings, and, the larger that will form will affect the performance of the proposed treatment strategy. It is likely that an operational balance will need to be developed to maximise pond volume to limit oxidation of the tailings.

13.3.2 ***Waste Rock***

The current waste rock management plan relies solely on segregation based on sulphur content to identify the potential for net acid generation. However no consideration appears to be given to metal leachability. The available geochemical assessment is based on a limited number of samples that may not adequately address the variability within the waste rock. It is further noted that the leachate concentrations obtained from the column leach tests were compared directly with water quality standards and no attempt was made to scale the leach rates to actual field conditions as they will be in the waste rock dump. In particular, the small scale waste rock column tests have shown a propensity to leach arsenic. Scaled to full scale the cumulative arsenic release rates may be significant and pose a significant environmental concern both during operations and after closure.

The water management plan for the water contained in the sediment pond is to recycle the water and use it as process water during the dry season, based on the modelling of the chemistry of water pooled behind the sediment dam. This would result in compliance with both Class I discharge standards and Class III receiving water standards for all parameters including arsenic. The modelling further indicates that discharge would only occur during the wet season.

The water quality modelling as presented in the technical supporting document (Kingett and Mitchell) is based on the assumption that the flow of seepage from the waste rock will be about $20m^3$ per day for the life of the project. The size of the waste rock dump will however increase with time to a maximum size of about 65 hectares (ha). The rate of increase in the footprint of the waste rock will be rapid during the earlier stages of the project (high initial strip ratio; narrow head of valley) and will slow toward the end of the project. Assuming a time weighted footprint for the life of project of about 45ha, the assume seepage rate of $20m^3$/day equates to net infiltration of about 16 mm per year, or about 1% of the annual precipitation. Experience elsewhere has shown that typical infiltration rates for uncovered waste rock dumps range from about 40 to 50% of the annual rainfall. The assumed seepage rate therefore has been underestimated and the net loadings of metals, in particular for arsenic may as a result have been underestimated by a significant margin.

It is also not clear whether or not the potential effects of the arsenic bearing solution on, for example, the BIOX® process has been considered. The proposed strategy may not be feasible at the higher seepage and metal loadings and contingency treatment plant may be required to maintain environmental compliance.

It is also noted that a significant proportion of the waste rock toe area may be inundated by the hydroelectric reservoir. This could cause the rapid release of a large volume of soluble products which will be difficult to capture.

13.3.3 ***Flotation Tailings and Treatment Solids Co-Disposal***

The BIOX® process generates an abundance of acidic solution with elevated metal concentrations including iron, arsenic and some base metals. The acidic water will be recovered in a counter current decant system and treated with lime to precipitate the dissolved metals as metal hydroxides and oxy-hydroxides and/or to sorb or co-precipitated some of the dissolved species. No testing has been undertaken to assess the long term stability of the solids that will be deposited in the flotation tailings impoundment.

The precipitates that will be generated by lime treatment are generally produced under oxidizing conditions. Once co-deposited with the flotation tailings, the treatment solids will be inundated within the porespace of the flotation tailings and oxygen will be excluded and the oxidation-reduction potential will change. This may lead to the re-dissolution of some metals as meta-stable phases reform and it is anticipated that arsenic and iron concentrations in the pore water will increase (Robins, 1990). This may result on impacts on the groundwater regime, and seepage in the longer term may impact surface water quality.

13.3.4 ***Soil Inventory and Management***

As noted in a later section, the rehabilitation and closure strategy remains conceptual in nature only. An inventory and management strategy for the pre-stripping and storage of the soils will be critical to the success of the proposed conceptual strategy and to achieve the land-use objectives after closure. It is also necessary to demonstrate through a soil inventory assessment that sufficient soil is available to complete the proposed closure strategy. Alternatively, suitable borrow sources will need to be identified that will be readily accessed and cost effective. While Sino indicated that soil will be available from the lower valley area below the waste rock dump to the Luofan River, access to the soils have not yet been negotiated. This land will however be compulsorily acquired by the applicable Chinese government agency during the dam fill stage of the Longtan hydroelectric scheme, which would suggest that Sino should have access to the soil. This will need to be verified by Sino. It is also not clear that haul distance and elevation differences have been factored into closure costs as discussed in the next section.

13.4 Rehabilitation Practices and Closure Costs

13.4.1 *Key Rehabilitation and Closure Issues*

A conceptual cover has been proposed for the CIL tailings area after closure of the mine. It is noted that the CIL tailings will be net acid generating, and as a result of the accumulation of treatment solids, will have a high potential for metals to leach from the tailings if the tailings continued to oxidize. While no weathering tests have been completed on CIL tailings it is anticipated that the metal loadings that may be contained in seepage post closure from the CIL could significantly impact the receiving water quality. No modelling has been undertaken to assess the rate of infiltration that will result or to estimate the rate of oxidation that results from oxygen diffusion through the cover layer. In our experience the proposed cover may not sufficiently reduce acid generation and an improved cover system will be required.

As noted before, metal leachability has not been scaled to the actual size and composition of the waste rock dump. Consequently, while no details of the proposed cover systems and water management strategies for the waste rock dump have been provided, there may be a significant risk that the current allowances for rehabilitation and closure of the waste rock dump may have been underestimated.

Similarly, no estimates of the potential final void water quality have been prepared. Depending on the flood elevation of the underground workings and open-pit, the water quality that may accumulate in the final voids may be of a poor quality and may impact on ground water and surface water quality. Again, no details have been provided on the proposed closure strategies for the final voids.

13.4.2 *Budgeted and Expected Costs*

While closure planning remains conceptual, Sino has indicated that an initial Closure Plan will be prepared during 2007 which will include commitments to return rehabilitated land at the waste dump to the local villages for distribution for agricultural or other uses as soon as practical. Sino has indicated that notional rehabilitation allowances are currently being provided for at the rate of US$60,000 per month, with an estimated life of mine expenditure of about US$8.5 million.

While descriptions have been provided of the works that will be undertaken, the interim allowances may not include allowances for soil handling and storage during prestrip and tailings facility construction.

Using the site specific load haul costs, we estimate that to place a 1 metre cover on all of the tailings and waste rock areas (based on the disturbed areas alone) will amount to about US$12 million. This does not include any allowances for pre-stripping and storage of topsoil for rehandling later. It also does not include engineering and or water management structures for final closure. Assuming that about 30% of the topsoil will be inventoried for rehabilitation (i.e. rehandled), including an allowance for engineering and a 15% contingency, the estimated total 'life of mine' rehabilitation and closure costs may amount to between US$18 million and US$20 million.

14. SOCIAL ASSESSMENT

14.1 Social and Community Interaction

Sino report that it has developed good relationships with the local community who are supportive of the Jinfeng mine and associated facilities. Sino has constructed improved local roads and electrical power infrastructure which will benefit the local community, which includes four villages (Bai Ni Tian, Shi Zhu, Tingshan and Niluo) and one township (Shaping). Sino has constructed a meeting hall adjacent to the entrance to the Jinfeng site and this building is used by Sino and the local community to meet and discuss community issues. Sino has an established Community Relations department which will continue to be staffed by Sino employees throughout the life of the Jinfeng mine.

14.2 Relationship with Local Government

The local government structure consists of several layers lead by the village Chief, town Mayor, County Mayor, Prefecture Governor and Provincial Governor. Sino report that it has established a good relationship with all levels of the local government.

15. SINO EXPLORATION PROJECTS

Sino has mineral assets and active exploration activities in three main mineral provinces in China, all of which are known centres of historic production or areas of potential for a significant gold deposit. Exploration is undertaken by Business Units in each mineral province under Sino's China Business Development (CBD) department, based in Beijing and led by an Executive Director. Suitable acquisition targets are also monitored and sought throughout China by the CBD.

As the basis for these activities, Sino has built up a GIS database of over 10,000 mineral deposits (the 'China Review').

The three main mineral province Business Units are:

- **Northern China** — includes White Mountain, an advanced gold deposit located in Jilin Province, Sanjianfang, and Beishan (North Mountain)

- **Shandong** — includes Ludi JV, Zhengyuan JV, and Hexi JV

- **Golden Triangle** — covering Guizhou and Guangxi Provinces, around the Jinfeng gold mine and including the Jinluo, Jindu, Guangxi, and Greatlands JV's.

SRK is familiar with the White Mountain exploration project from detailed work done on the geology and structural controls on mineralisation at that deposit. In addition, as part of this review, time was taken to visit and review the sites at key exploration prospects in the Golden Triangle. Prospects in the Jinlou JV (Naxi, Bannian, Banna) were visited in addition to the Pogao prospect at the Jindu JV. The other projects and prospects are in early stages of exploration and as such there is relatively little to review on site. As a result, the other prospects and joint venture projects mentioned in this report were reviewed in discussion with Sino and joint venture exploration geologists and from written or published material.

On 22 November 2006, Sino announced a new strategic alliance for exploration in China which will be jointly funded and include Gold Fields Chinese joint venture exploration licences and Sino joint venture exploration licences, excluding the Sino joint venture exploration licences around the Laizhishan Dome area near Jinfeng and the White Mountain project. The strategy is to explore for porphyry, high-sulphidation epithermal and sedimentary-hosted disseminated orogenic style gold mineralisation. These are not currently the focus of Sino's exploration program in China. The strategy will be to discover a deposit that has at least a 5 million ounces Resource and has the capacity to be mined with an annual gold production of approximately 500,000 ounces. This strategy differs in style of mineralisation and target size from the former Sino strategy on which the existing joint venture projects are based.

15.1 Golden Triangle Business Unit

The Golden Triangle Business Unit (GTBU) was formed in late 2005 to explore the Golden Triangle area surrounding the Jinfeng project. The Golden Triangle is a significant mineral belt in China which spans Guizhou Province (including Jinfeng Resource), Guangxi Province and parts of Yunnan Province. The area is part of the extensive Youjian Basin, which consists of Silurian to Triassic-aged sedimentary units deposited in a marine setting and subsequently inverted (folded and uplifted) during the late Triassic and Jurassic.

The GTBU includes the following mineral assets (Figure 15-1):

- Jinfeng EL's consolidated into the JF42 (3 EL's covering 42km^2 around the Jinfeng development and mine lease)
- Jinluo JV (1 EL, covering 97km^2)
- Jindu JV (19 EL's covering 400km^2)
- Guangxi JV with (GIRGS) (14 EL's covering 200km^2)
- Greatlands Project JV (7 EL's covering 115km^2)

In addition, the business development focus will be to acquire and review additional regional data with the aim of identifying new targets in the Golden Triangle.

The GTBU aims to add 3 to 5 million ounces of new gold resources in the next 3 to 5 years through existing and new JV initiatives. The area is strategically significant given the location of the Jinfeng project within the Golden Triangle, similar styles of mineralisation in the exploration areas to that at Jinfeng and the possibility of mining newly discovered Resource within reasonable truck transport distance of the Jinfeng project should there be capacity to take additional ore.

Within the Golden Triangle, district to regional scale interpretations of satellite, topography and airborne magnetic data indicate a strong relationship between Carlin-style (replacement) gold occurrences in the Golden Triangle and re-activated basement faults (SRK, 2004). These interpretations provide a framework for developing targets and acquiring access to prospective ground.

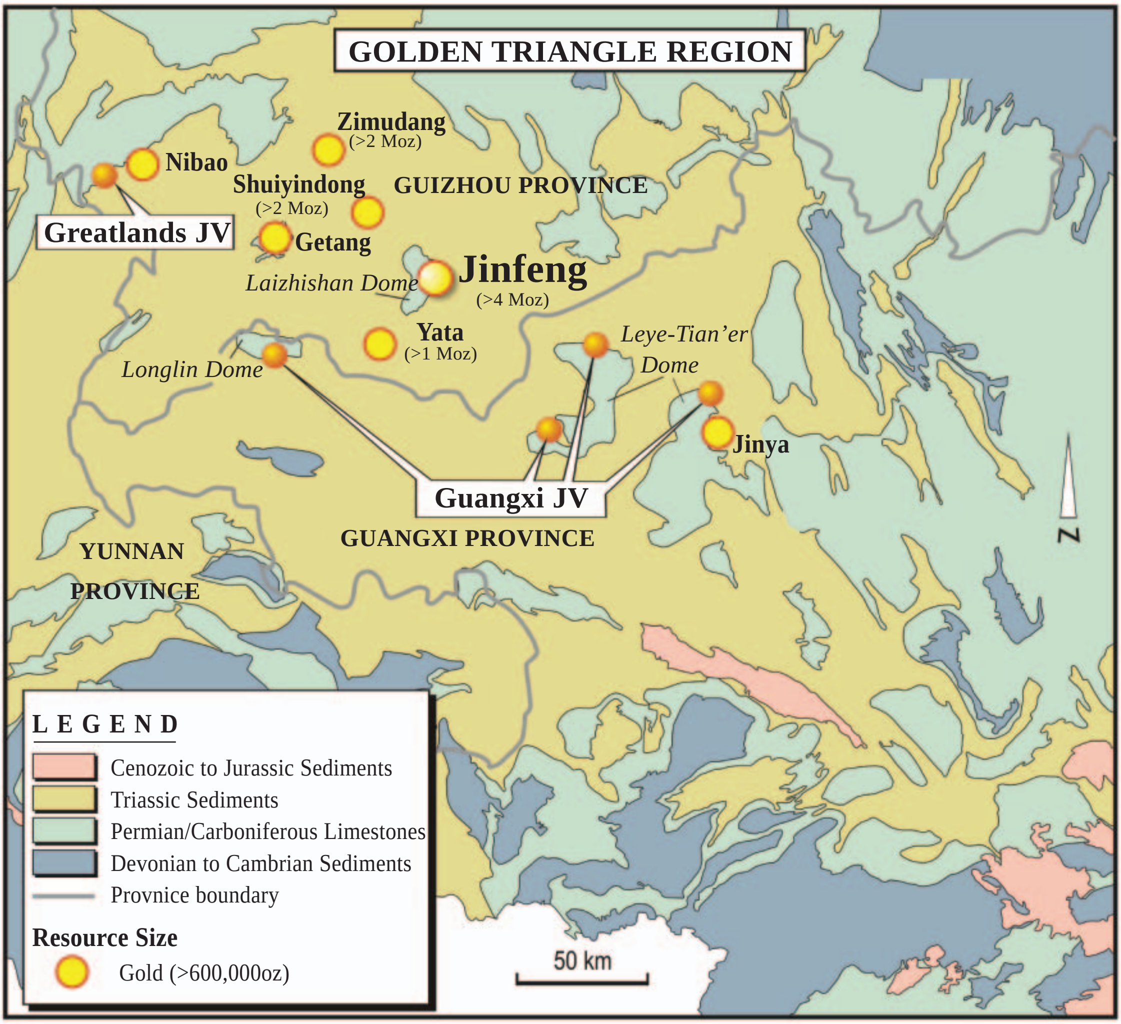


Figure 15-1: Regional geology and location of the Exploration area of the Golden Triangle Business Unit

15.1.1 *Exploration Methodology*

Surface Geochemistry

Stream sediment geochemical samples are taken at –80 +20#, following orientation surveys and analysis of different stream sediment fractions. Sample density aims to take one sample for each 1 km^2 drainage area.

Near surface (B-horizon and C-Horizon) soil samples are acquired to follow up on stream sediment anomalies or highly anomalous rock chip geochemistry where there is relatively little outcrop. The GT business unit routinely takes soil samples at 40m sample spacing.

Trenching

Surface trenching is done to expose the geology and provide an area for continuous geochemical sampling of the rocks at surface. Exposure of the rock is possible only where weathering is relatively shallow and cover sedimentary sequences are thin. Surface trenching is commonly done to a maximum depth of 2 metres vertically with individual trenches commonly being 1 metre across.

Geophysics

Ground electrical geophysics, Induced Polarization (IP), is routinely used by exploration to support the surface mapping and trenching and to identify sub-surface disseminated sulphide (pyrite, arsenopyrite) mineralisation. Several different dipole spacings and different generator capacities have been used, however a 50m dipole spacing and 30kW generator capacity has returned the best results in the Golden Triangle areas of interest. The IP aims to test the subsurface down to a depth of approximately 500m.

Ground magnetic surveys over individual prospects are rarely used, although regional magnetic data is available to assist with licence-scale geological interpretation and targeting.

In SRK's opinion, Sino are employing sound exploration techniques which are appropriate for their geographic areas of interest and for gold exploration in China. In SRK's opinion, the techniques are based on sound orientation surveys aimed at optimising the techniques and precision of the results obtained.

Drilling

Drill testing is commonly done by recovering diamond core using man-portable drill rigs that are capable of drilling up to 300m. Sino diamond drill holes are commonly angled to achieve a sample across steeply dipping structures, although many of the older drill holes are vertical.

The samples are recovered from the drill site and transported back to the exploration workshop for logging and measurement of recovery and density.

15.1.2 *Jinfeng near Mine EL's (JF42)*

Three Jinfeng JF42 JV exploration licences have been consolidated into one Joint Venture as part of the Jinfeng Project, surrounding the Mining Lease, which is 82% held by Sino (Figure 15-2 and Figure 15-3). Since 2004, the JV exploration licences have been explored by Sino for Carlin-style replacement gold mineralisation similar to that at Jinfeng.

Exploration on the JF42 licences aims to identify additional Resources which could add to the current Jinfeng project or become a stand alone operation. Exploration to date has been unable to significantly add to the Resource that exists on the Jinfeng Mine Lease.

During 2005, the following exploration completed included:

- Three diamond drill holes (total of 475m) at Laowuji Prospect to follow up on high grade trench results, however no significant results were returned from the drilling program

- Drilling at Lintan prospect to follow up on high-grade trench results. Three older holes were drilled here by the BGMR and one hole by Sino with no significant intersections returned

- Trenching at Yaojiatian where a zone of elevated gold and arsenic has been found. The best result in the trench was 8m at 1.7g/t Au

- IP surveys were completed at Anbao and Gaolu prospects to the north-west of Jinfeng.

During 2006, the following exploration completed included:

- Gaolu prospect, where first phase of three drill holes was undertaken, targeting deep targets in favourable host rocks adjacent to the north-west extension of the F7 fault

- The south-east extension of the F3 outside the Mine Lease

- The F7 at Weixi, where drilling intersected 1m at 2.2g/t Au and 2m at 2.7g/t Au in the fault (hole JFW020).

- The north Rongban area, along strike to the north-west from the Rongban deposits on the mine lease, where low-grade gold and high arsenic values were returned from samples in surface trenches in that area.

The current exploration program which will extend into 2007 is concentrating on mapping and identification of deeper targets. Currently, the surface drilling programs have been completed, and have been unable to add to the Resource. There remains potential for deeper targets which may have underground mining potential. Deeper targets may have a slightly different style of mineralisation than that at Jinfeng. The structural models remain the same with intersections between north-west trending faults and north-east trending faults remaining the primary target. Further work will focus on:

- The F7 at depth down dip of the main Jinfeng Resource but off the Mine Lease

- The F3 to the south-east of the Mine Lease

- The F14 at Lintan which is considered to be similar to the F3 at Jinfeng

- The F70 at Yaojiatian

- The F8 at Laowuji Prospect

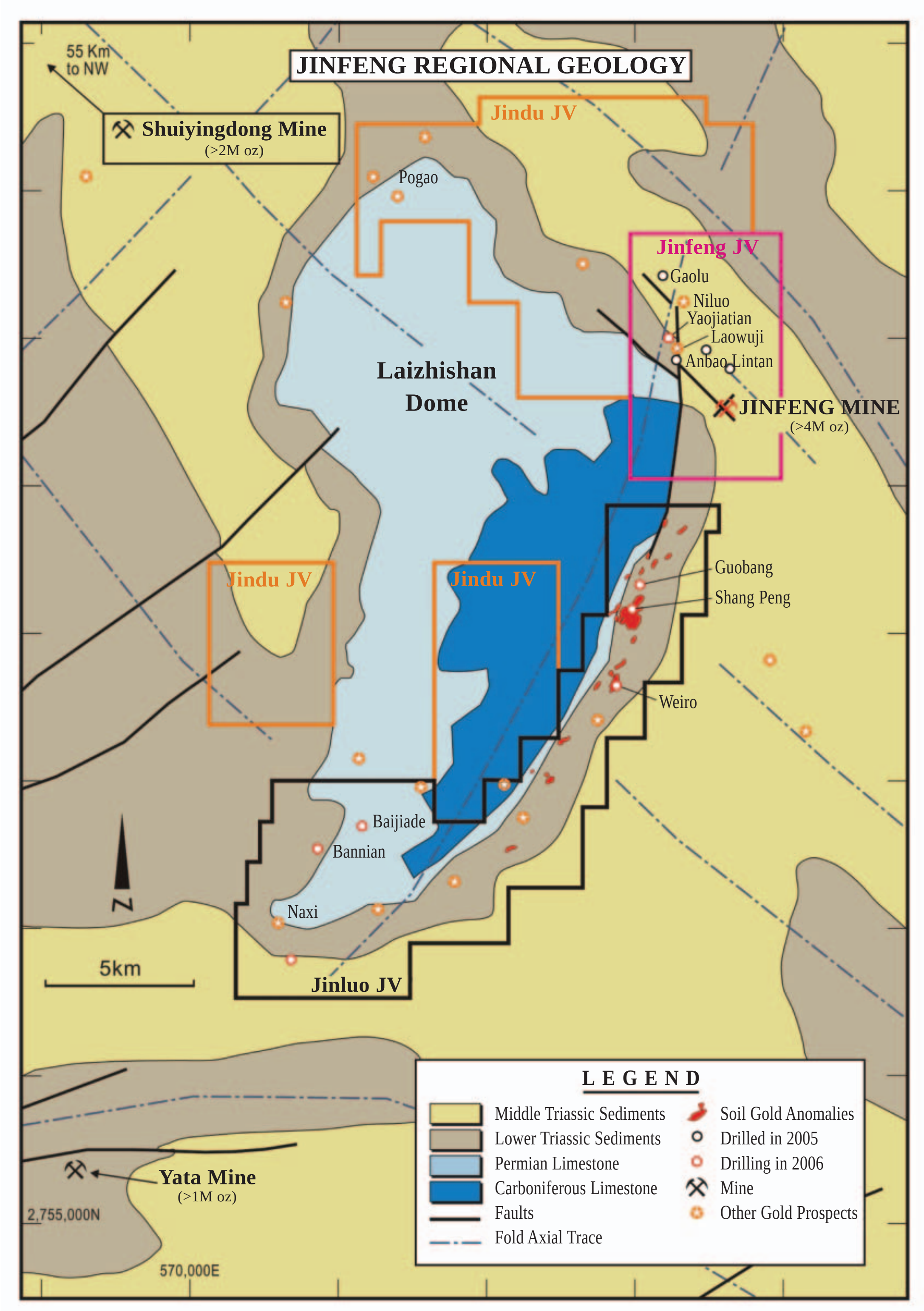


Figure 15-2: Location of the Jinfeng JV

(JF42, being 42km^2 of exploration licence around the Jinfeng Mine Lease, location of the Jinlou JV licence and location of the Jinlou JV licences relating to the Laizhishan Dome (source: Sino June 2006 quarterly report)