Mineral processing technology — Intec Ltd — A$0.049

W.H.I. SECURITIES RESEARCH

Intec's halide-based, hydrometallurgical mineral processes offer significant cost, performance and environmental benefits over existing alternatives.

Capital structure

ASX Code (02/05/02→)	INL
Share price	A4.9¢
Market capitalisation*	A$6.0m
Market cap. post-rights	A$8.6m
Shares on issue	122.1m
Post-rights	209.7m
Escrowed (02/05/04)	24.0m
Unlisted options	8.6m
12-month low-high	A1.8-12¢
12-month volume	6.6m

* undiluted

Directors

Chairman	Kenneth Severs
CEO & MD	Philip Wood
CFO	Kieran Rodgers
Technical director	John Moyes
Non-executive	Philip Evans
Non-executive	Gordon Toll

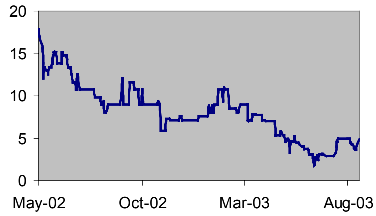
Top 5 shareholders

Ivanhoe Mines Ltd	19.9%
Excel Mining Ltd	10.5%
Exchange Nominees	10.2%
Michelle Everett	6.7%
Peter Everett	6.7%

Registered office

Gordon Chiu Building, J01
Department of Chemical Engineering
Maze Crescent, University of Sydney
NSW 2006 Australia
Tel: +61 (0)2 9351 6741
Website: www.intec.com.au

Price chart (A¢)



Source: IRESS

Analyst

Duncan Hay
Tel: +61 (0)2 9222 9111
Email: djhay@whisecurities.com.au

18th August 2003

KEY POINTS

- Intec Ltd is the world leader in halide-based mineral processing technology and is developing a suite of low-cost, environmentally safe methods for the extraction of gold, PGMs and base metals
- Following the 2002 IPO, Intec is now proceeding to commercialisation, beginning with the Intec Gold Process (IGP).
- To assist with IGP development and commercialisation, Intec has announced a 3-for-5 renounceable rights issue to raise A$2.6m.
- Intec is looking to gain acceptance for its processes in the mining industry by developing metals producing projects with important equity partners.

INTEC GOLD PROCESS (IGP)

- Successful commercialisation of a new low-cost treatment route for refractory gold deposits could have industry-wide ramifications.
- Studies show that Intec's IGP could provide benefits over conventional alternatives and WHIS has estimated the following gains in NPVs$_{10\%}$ for an illustrative 80,000ozpa gold operation:

Intec Gold Process	***A$24m***	***-***	***-***
Geocoat	***A$20m***	***Benefit***	***+A$4m or 20%***
Pressure oxidation	***A$16m***	***of using***	***+A$8m or 50%***
Bacterial oxidation	***A$10m***	***IGP***	***+A$14m or 140%***

- The gold industry with its high value output offers the company several commercialisation advantages and earlier cash flows.
- Intec's construction of an A$0.5m, 5-10kg/hour IGP pilot plant by end-2003 will assist its global marketing.
- Robert Friedland's Ivanhoe Mines is assisting and will fund the construction, commissioning and initial operation of the pilot plant.

OVERVIEW

- The 15 months since Intec's listing have been difficult for both the resources and technology sectors.
- Low prices for base metals and historic lows in treatment charges have hindered commercialisation of INL's processes, given the reluctance amongst concentrate producers to commit to processing alternatives in such a favourable cost environment.
- However, the flexibility of Intec's generic process has let it switch focus and it is now well placed to commercialise the IGP.
- In the short to medium-term, Intec offers excellent exposure to likely improvements in base metal prices, while in the longer-term, its processes could change the face of the mining industry.

1.0 RIGHTS ISSUE

On the 17th June 2003 Intec announced a three-for-five renounceable entitlement to existing Intec shareholders, consisting of 87.6m new shares at A$0.03 per share to raise A$2.6m.

The company intends to use the proceeds of the rights issue to:

- *Further develop and commercialise the Intec Gold Process (IGP)*
- *Use as working capital for development of its other mineral processing technologies*

Details of the rights issue:

- *Three-for-five renounceable entitlement to existing Intec shareholders*
- *87,623,490 new shares at A$0.03 per share to raise A$2,628,705*
- *Prospectus dated 7th August 2003*
- *Closing date for issue is 5pm AEST on 11th September 2003.*
- *Joint Underwriters – Taylor Collison Ltd and Grange Securities Ltd*
- *Orian Holding Corp. (wholly owned by Robert Friedland's Ivanhoe Mines) has agreed to fully subscribe to its rights and sub-underwrite up to 32.6m shares (A$978,000)**

**N.B. Orian Holding Corp. has also agreed to provide the capital, commissioning and operating costs for the A$500,000 IGP pilot plant to be built at Ammtec's facilities, in northern Sydney in return for a worldwide IGP licence on favourable commercial terms.*

Key dates of the rights issue:

• *Announcement of the issue*	*17th June 2003*
• *Lodgement of prospectus with ASIC and ASX*	*7th August 2003*
• *Application to ASX for official quotation of shares*	*7th August 2003*
• *Notice to shareholders*	*11th August 2003*
• *Record date to determine entitlement to new shares*	*18th August 2003*
• *Prospectus and entitlement and acceptance forms dispatched*	*21st August 2003*
• *Last day of entitlement trading*	*4th August 2003*
• *Acceptances and renunciations close at 5pm (AEST)*	*11th September 2003*
• *Dispatch of holding statements*	*2nd October 2003*

2.0 COMPANY PROFILE

Intec was established in 1973 and since then has been developing electrochemical and hydrometallurgical processes for the extraction of metals from ores, concentrates and residues.

In the 1980s, current shareholder Anglo American entered into a licence/royalty agreement to jointly advance Intec's hydrometallurgical electrowinning technology, leading to the development of the Intec Copper Process (ICP) by 1989.

In 1990 BHP funded a A$1m study which proved the economic advantage of the ICP over conventional techniques. In 1992 the ICP was patented and Intec Copper Pty Ltd formed to develop and commercialise the process.

The Intec Copper stage 1 pilot plant (55kg per day) was funded by an international consortium of mining and metals companies and operated for a total of 290 days between 1994 and 1995, by which time it was producing LME 'A' Grade purity copper. In 1998 a US$10m stage 2 demonstration plant (1 tonne per day), funded by industry and the Federal Government, was constructed in Sydney, and in 8 months produced 190 tonnes of copper metal.

Intec Ltd listed on the ASX (code: INL) in May 2002 after raising A$5m in a fully subscribed IPO.

The company is now developing and commercialising its technology with a number of strategic international partners, including Ivanhoe Mines, H.G. Engineering, Nippon Mining & Metals and Rautomead International.

2.1 Directors

Non-Executive Chairman – Kenneth J Severs (65)
Chemical engineer for >40 years. 24 years with Anglo American (1964-1988) and 9 years (1990-1999) as Group Metallurgical Executive for Rio Tinto (London).

CEO & MD – Philip R Wood (50)
Lawyer, formerly with Macquarie Bank (Sydney), James Capel & Co (London) and Resource Finance Corporation (Sydney).

CFO – Kieran Rodgers (44)
13 years corporate and investment experience with RFC, primarily focused on Australian/international resources stocks.

Technical Director – A John Moyes (54)
>30 years in the mining and metals industry and for the past 13 years with Intec as Project Manager, then General Manager and (since 1995) Technical Director.

Non-Executive Director – J Philip Evans (66)
Over 40 years experience in hydrometallurgy and current president of Intec shareholder H.G. Engineering.

Non-Executive Director – Gordon L Toll (64)
>30 years experience in international resources, energy and chemicals. Current deputy chairman of Ivanhoe Mines.

2.2 Top 20 shareholders

Shareholder	*Shares*	*%*	*Shareholder*	*Shares*	*%*
Orian Holding Corp. (Ivanhoe)	29.00m	19.9	Dr Bryce Russell	1.60m	1.1
Eureka Capital Partners Ltd (Excel Mining)	15.29m	10.5	Beach Partners LP	1.33m	0.9
Invia Custodian Pty Ltd (CIBC)	14.86m	10.2	Smacer Pty Ltd	1.25m	0.9
Michelle Joy Everett	9.77m	6.7	Reach Out Pty Ltd	1.20m	0.8
Mr Peter Kenneth Everett	9.77m	6.7	Plymouth Holdings Inc	1.12m	0.8
Clodene Pty Ltd	3.54m	2.4	Mr Roderic Holliday-Smith	1.11m	0.8
Grizzly Holdings Pty Ltd	2.40m	1.6	Bluestar Management Pty Ltd	1.05m	0.7
H G Engineering Ltd	2.25m	1.5	Anglo American Corp. SA	1.00m	0.7
Mr William E Conway	1.81m	1.2	Parma Financial LLC	1.00m	0.7
Mr Peter Colin Taylor	1.75m	1.2	Mr Jeff Beach	0.98m	0.7

2.3 Financial history

Year end 30th June (A$000s)	*2001*	*2002*	*Dec-2002*
Total assets	1,255	3,867	2,725
Cash	1,149	3,748	2,370
Debt	364	-	-
Net assets	738	3,612	2,392
Revenue	63	178	194
Earnings	(184)	(3,097)	(1,219)
EPS (A¢)	(0.02)	(2.56)	(0.9)

Source: INL

3.0 INVESTMENT REVIEW

- ***Over the last decade, Intec has been developing a suite of low-cost, environmentally safe processing methods that could produce precious and base metals on site from ores, concentrates and residues.***

- ***The Intec Gold Process (IGP) has been developed to treat refractory (i.e. difficult to treat) gold concentrates and is being commercialised in conjunction with Robert Friedland's Ivanhoe Mines, an INL shareholder, which is to fund a A$0.5m IGP pilot plant, expected to be operating by end-2003.***

The mining industry is always seeking new processing methods that will lower costs and allow maximum on-site value-adding. An operation producing concentrates incurs higher unit transport costs (volume related) and pays downstream treatment and processing charges (TC/RCs). However, a mine that produces a pure metal typically has a more readily marketable and more easily transported product.

Breakthroughs such as SX-EW (acid solvent extraction-electrowinning) for treating copper oxide ores and CIP (carbon-in-pulp) for treating non-refractory sulphide gold ores were prompted by ore availability, and have significantly changed the face of the mining industry.

The global inventory of gold deposits that have refractory minerals is large and these are ideal candidates for a new processing technology. Furthermore, refractory deposits make up around a third of current world gold production and this can only increase as shallow oxide ores are mined out and deeper sulphide ores accessed.

Gold liberation when processing a refractory ore is typically inhibited by minerals such as pyrite or arsenopyrite, which must be eliminated to allow reasonable gold recovery. Roasting is often used to break-down refractory concentrates, however, associated capital and operating costs can be high. Treatment of the noxious by-products also makes environmental permitting difficult. Costs for bacterial/pressure oxidation are also high and use of such processes is limited to higher tonnage operations.

Intec Gold Process (IGP) – the new priority
Since the IPO, Intec's commercialisation strategy has suffered as a result of both depressed base metal markets and low TC/RCs. The number of new projects being developed has been limited due to price, and existing concentrate producers have been reluctant to commit to alternative processes in such a low treatment charge environment.

However, the character of the generic Intec Process, and the company's 10 years of experience in halide chemistry, has allowed Intec to focus on the IGP, which has been developed to treat concentrates from refractory gold deposits.

Intec expects the proprietary IGP to provide significant cost and environmental benefits when compared to existing competing processes, and by proving it at a commercial scale, Intec could initiate industry-wide change.

WHIS has estimated the following $NPVs_{10\%}$ for an illustrative 80,000ozpa, North American gold operation:

Intec Gold Process	*A$24m*	*-*		*-*
Geocoat	*A$20m*	*Benefit*	*+A$4m*	*+20%*
Pressure oxidation	*A$16m*	*of using*	*+A$8m*	*+50%*
Bacterial oxidation	*A$10m*	*IGP*	*+A$14m*	*+140%*

This value enhancement would provide a tangible financial benefit to Intec.

Operating in the gold industry offers Intec a number of commercialisation advantages, including low entry barriers, a large number of participants, and ultimately the opportunity for earlier cash flows than from its base metal technology.

The A$0.5m IGP pilot plant is expected to be operating by end-2003 and once the technology has been proven (probably using Ivanhoe's concentrates) operating costs should be covered with future third-party test work fees.

Intec is looking to become a project-based metals producing company, ideally by developing operations on an equity basis with partners, however, it has several other value-adding options, such as royalties and consulting fees.

The company is in discussion with a number of companies that have already supplied feedstock for laboratory-scale testing with a view to further pilot-plant testing and then ideally project equity-for-licence deals.

- ***As with any new technology, much of the investment risk lies with commercialisation, and particularly how delays will initially affect cash reserves and ultimately the company's ability to raise further equity.***

- ***However, by proving the IGP at pilot plant level, Intec will have taken a major step towards commercialisation and given the number of refractory gold projects that would benefit from a low-cost, environmentally safe alternative to existing processing methods, full commercialisation seems achievable.***

4.0 STRATEGIC PARTNERS

Intec is developing and commercialising its technology with a number of strategic partners that have significant influence in the global mining sector for a number of reasons, including:

- *Track records of innovation*
- *Extensive international industry experience*
- *Large balance sheets*

Ivanhoe Mines Ltd
Robert Friedland's Ivanhoe Mines was the cornerstone investor in Intec's May 2002 IPO. The ASX/TSX-listed company is developing an important new porphyry gold and copper discovery in Mongolia, and has negotiated exclusive rights to use the **ICP** and **IGP** under royalty-based licence. Gordon Toll, an executive director and Deputy Chairman of Ivanhoe, is also a non-executive director of Intec.

In April 2003 Ivanhoe formed an alliance with the **China International Trust & Investment Corporation (CITIC)**, a US$50bn Chinese state-owned enterprise, to jointly develop Asian mineral projects and thus help to meet China's current and future metals requirements. As part of this alliance, Ivanhoe and CITIC will be looking to introduce new mineral processing technologies to various Asian mining projects, including those of Intec.

H.G. Engineering
H.G. Engineering has been assisting Intec since 1995, principally through its President Philip Evans, a non-executive director of Intec. The Toronto-based firm has completed cost studies for potential projects using the ICP.

Nippon Mining & Metals (NMM)
NMM has two copper production facilities in Japan and annual smelting and refining capacity of around 450,000 tonnes. NMM co-funded the development of the ICP from 1993 to 1999 in Sydney and as a result is an Intec Copper sub-licensee. Intec is working closely with NMM on the commercial development of the ICP in Japan, where NMM is operating a pilot plant with production capacity of 100kg per day of copper.

Rautomead International Ltd
This is a privately owned Scottish company specialising in the continuous casting of non-ferrous metals. Intec and Rautomead have signed a joint Heads of Agreement to combine their technologies in a copper concentrates-to-wire rod package, and once successfully developed, will enter into a joint marketing initiative.

Intec has completed laboratory-scale tests on refractory concentrates from the following projects:

Company	*ASX code*	*Project*	*Overview*
Ashburton Minerals	ATN	Wirralie Project, QLD	Contains 100,000oz shallow oxide resource and 300,000oz sulphide resource – looking to recommence mining by end-2003. INL has achieved 93.3% recovery.
Goldcorp	G (TSX)	Red Lake Mine, Canada	500,000ozpa very high-grade, low-cost operation, which has had arsenic issues. Plans to expand to 700,000ozpa.
Ivanhoe Mines	IVN	Bakyrchik Mine, Kazakhstan	13Moz gold deposit that has had limited production primarily because of recovery problems.
Western Metals	WMT	Hellyer Tailings Project, TAS	11Mt of tailings at 2.6g/t gold, 88.0g/t silver, 2.8% zinc, 3.0% lead and 0.2% copper. Lab-scale testing to proceed.

Source: Various company websites.

5.0 DEVELOPMENT ROUTE

Intec's proposed short-term IGP development route is as follows:

Item	*Completed?*
Laboratory-scale leach trials to establish gold extraction efficiency and reagent consumption.	✓
Construction and operation of 5-10kg/hour IGP pilot plant at Ammtec's facilities in northern Sydney.	*By end-DQ03*
Project feasibility studies leading to commercial project interests.	*Ongoing from start calendar 2004*

6.0 INTRODUCTION TO INTEC'S PROCESSES

Over the last decade Intec has developed a number of halide-based, hydrometallurgical processes for the production of pure precious and base metals from gold, copper, nickel, zinc and lead ores:

Gold – the patented (pending) Intec Gold Process (IGP) has been proven at laboratory-scale to recover gold and other by-products from metallurgically complex, refractory gold concentrates.

Copper – the patented Intec Copper Process (ICP) has been proven at demonstration plant-scale to produce pure copper and precious metals from metallurgically complex sulphide concentrates.

Nickel – the patented Intec Nickel Process (INP) has been proven at laboratory scale to produce high purity nickel metal and associated by-products from metallurgically complex sulphide concentrates.

Zinc – the patented (pending) Intec Zinc Process (IZP) has been demonstrated in a small pilot plant to recover zinc from complex sulphide concentrates. Demonstration plant-scale testing is to follow.

Intec expects to commercialise all its processes, commencing with the IGP.

6.1 The Intec Copper Process (ICP) – the successful earlier focus

Most of the company's work to date has focused on the production of copper metal, however, Intec's processes have been successfully demonstrated to produce a number of high-purity base and precious metals.

The Intec Copper Stage 1 pilot plant (55kg per day) operated for a total of 290 days between August 1994 and November 1995 and by the end of this period was producing LME 'A' Grade purity copper.

In 1998 a US$10m stage 2 demonstration plant (1 tonne per day) programme was commissioned on the outskirts of Sydney, and in 8 months the plant produced 190 tonnes of copper metal. The plant was dismantled in 2000 due to the high maintenance costs.

Figure 1: The ICP demonstration plant, St Peters, northern Sydney

Source: INL

Nippon Mining & Metals Co Ltd (NMM) partly funded the ICP pilot and demonstration plants and in January 2003 constructed and commissioned an Intec Copper pilot plant at its research and development facilities at Hitachi, Japan.

Although Intec still has the option of initiating full-scale production with small (25,000tpa of metal, CAPEX US$40m), commercially viable 'entry level' copper plants, the nature of the gold sector is such that it should allow easier commercialisation of its processing technology and therefore the opportunity for earlier cash flows.

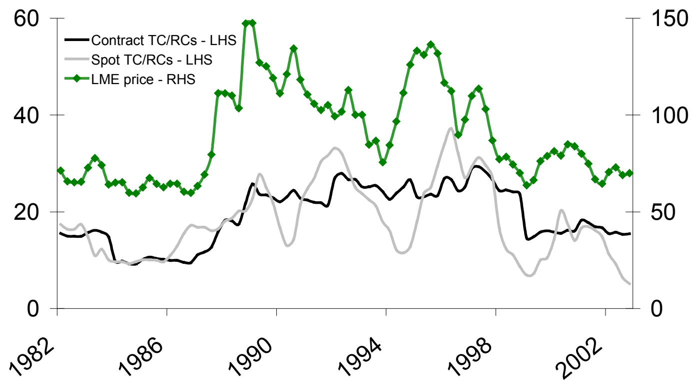
7.0 THE INTEC GOLD PROCESS (IGP) – the new priority

Intec's commercialisation strategy has been hampered by depressed base metal markets and historic lows in treatment and refining charges (TC/RCs) – see figure 1.

The low TC/RCs have made concentrate producers reluctant to commit to processing alternatives, given the favourable, low-cost environment.

Despite this set back, the flexibility of the generic Intec Process, and the expertise in halide chemistry that the company has acquired over the last 10 years, has allowed it to focus on the Intec Gold Process (IGP).

Figure 2: LME copper price and copper TC/RCs (US¢)



Source: INL

Intec has developed the IGP to recover gold and other by-product metals from the concentrates of refractory gold deposits, at low-cost, moderate temperatures, atmospheric pressure and without cyanidation.

The high-performance process is also effective at treating low-grade and/or metallurgically challenging concentrates.

Intec expects the IGP to provide significant cost and environmental benefits when compared to existing processes such as roasting, bio-oxidation and pressure-oxidation.

7.1 Refractory gold deposits

Refractory gold deposits are those with metallurgical characteristics that inhibit gold recovery. Around one third of current gold production is from refractory gold deposits and this seems likely to increase in the future as shallow oxide resources are mined out and the deeper sulphide ores accessed.

There are several factors that can render gold-bearing ore refractory:

Type	*Causes of refractory characteristics*
Liberation	Physical locking in silicates, sulphides, carbon etc.
Occlusion	'Passivation' due to formation of a chemical layer.
Chemistry	Occurrence of auriferous minerals e.g. gold tellurides and aurostibnite.
Substitution	Elemental replacement by gold in mineral lattice, e.g. solid solution gold in pyrite ores.
Adsorption	Adsorption of dissolved gold by active [preg-robbing] carbonaceous material in the ore pulp.

Source: INL

Intec has developed the IGP to specifically deal with ore types rendered refractory by substitution and adsorption, categories into which most of the world's gold reserves and resources fall.

Within these categories, Intec is tailoring its process to deal with three main ore types:

1) ***Those containing gold mostly in pyrite (or other sulphides)*** – "substitution" above

2) ***Those containing gold mostly in arsenopyrite*** – "substitution" above

3) ***Those containing gold in pyrite and/or arsenopyrite <u>and</u> preg-robbing carbon*** – "adsorption" above

7.2 Treating refractory concentrates

The typical treatment of a refractory ore would involve oxidation of a grind-flotation concentrate, extraction of gold from the resulting residue using cyanide and then recovery of gold onto activated carbon.

The IGP differs from existing hydrometallurgical alternatives (e.g. oxidation and biological/bacterial oxidation) in that it uses a halide-based, rather than sulphate-based medium (i.e. leachate).

- ***Sulphate-based hydrometallurgical processes (conventional)***
  Gold is insoluble in sulphate-based leachates and when these are used to treat a refractory gold ore/concentrate, cyanide is needed to dissolve the gold following oxidation of the sulphides.

- ***Halide-based hydrometallurgical processes (IGP)***
  In the IGP, sulphide oxidation and gold dissolution occur simultaneously. Once the oxidised sulphide slurry has been separated from the pregnant (i.e. gold bearing) solution, gold can be recovered by conventional adsorption onto activated carbon.

Use of the IGP eliminates the often prohibitive cost of a second cyanide leach circuit and cyanide destruction.

7.3 IGP – background

Development of the IGP was initiated by Intec's main shareholder, Canadian-based, ASX/TSX-listed Ivanhoe Mines.

Ivanhoe is currently developing a number of refractory copper-gold projects, including the impressive Turquoise Hill in Mongolia, which is believed to be one of the world's largest copper-gold porphyry systems.

Intec began development of the IGP by applying its copper process to concentrates from Ivanhoe's 70% owned Bakyrchik Gold Mine in north-eastern Kazakhstan, which is currently under care and maintenance.

Ivanhoe first gained an equity interest in the Bakyrchik Mine in 1996 and by 1999 had acquired 70% (Government of Kazakhstan 30%) at a total cost of around US$65m. Although limited production from stockpiled ore recommenced at the end of 2001, with 2664oz produced in 2002, operations were suspended later in the year due to ongoing metallurgical and associated technical problems.

Beneath the oxide cap that was the source of the stockpiled ore mentioned above lies a large refractory gold resource, which consists of a series of mineralised lenses lying within a 12km shear zone. Gold is hosted within sheared carbonaceous sediments and found within sulphides that occur in association with quartz stockworks.

A total resource of approximately 13Moz gold has been estimated for the project, consisting of 10.5Moz from a definitive feasibility study completed by Minproc Engineers Ltd of Perth in December 1996, and an additional 2.5Moz outside the DFS area calculated by Western Services Engineering of San Ramon, California.

In 1997, Kvaerner Metals was assigned to prepare a 'Basic Engineering Report' for the project and concluded the viability of a mining operation of 512,500tpa (150,000tpa of ore to 37,500tpa of concentrate by flotation, combined with 362,500tpa of whole ore as roaster feed), and a carbon in leach (CIL) plant to be located at Bakyrchik, producing 120,000-130,000ozpa gold in doré. Kvaerner estimated cash operating costs below US$200/oz for the first five years and average US$214/oz for the 15-year term of the report.

However, most gold in the Bakyrchik sulphide resource is contained within arsenopyrite (some pyrite) and the carbon-rich sediment association renders the ore "double refractory" and notoriously difficult to process. The carbon content of the oxide ore greatly reduced recoveries in the 2001-2002 limited operation (average recovery 45%, target 90%).

Ivanhoe is investigating the IGP as an alternative to conventional processing methods and has agreed to provide sufficient funds to construct, commission and initially operate the forthcoming pilot plant.

7.4 Commercialisation of the IGP

As already mentioned, the gold industry offers several commercialisation advantages to Intec, including low barriers to entry, a high degree of fragmentation and a track record of innovation and entrepreneurship.

Intec has already completed successful laboratory testwork on concentrates from Ivanhoe's Bakyrchik project and a number of other refractory gold deposits and believes that the advantages of the IGP over existing processes will be greatest for refractory gold deposits with an arsenopyrite association – i.e. no oxidation plant needed.

Therefore, the company will be looking to identify single refractory deposits, ideally with an arsenopyrite association, with a view to outright acquisition or negotiation of a direct or indirect project cash flow through IGP licensing.

7.5 The IGP pilot plant

Intec expects to have a A$0.5m, 5-10kg/hour IGP pilot plant up and running by end-calendar 2003, and will most probably use Bakyrchik concentrates to prove its technology. After this it will run the plant on a campaign basis and expects to cover operating costs with future test work fees.

Intec believes that scaling up the IGP to pilot plant scale will be relatively low risk for a number of reasons, including:

- ***IGP components and materials are almost the same as for the ICP***
  The ICP was operated successfully at a 1 tonne per day demonstration-plant scale for approximately 1 year.

  Materials to be used include conventional fibreglass-reinforced plastics for tanks and piping and conventional plastics for pumps. Corrosive-resistant mixers are made from titanium as is standard practice in pressure oxidation processes.

- ***Metal has been extracted from a similar chemical matrix to the IGP by the nickel industry for many years***
  At the metal recovery stage of the IGP, Intec can benefit from the experience that has been gained by the nickel industry in the production of nickel metal from nickel sulphide matte in a very similar chemical matrix.

7.6 IGP – the process

Intec has developed the IGP to recover gold from refractory concentrates containing arsenopyrite, pyrite and carbon.

Arsenopyrite and pyrite refractory concentrates will typically have gold locked within the lattice of the respective minerals (i.e. in solid solution rather than as native gold) and the IGP must break these lattices through oxidation before leaching the gold ahead of recovery onto activated carbon.

Carbon at sufficiently high grades (3-5%+) within the concentrate will take gold from the leachate ("preg-rob") and may require roasting prior to calcine leaching and subsequent recovery onto activated carbon.

The IGP typically involves the simultaneous oxidation and leaching of metals from a gravity/flotation concentrate by a halide-based solution, followed by precipitation of contaminants and then gold recovery onto activated carbon.

Figure 3: The basic steps of the IGP

1. For pyrite concentrates

Oxidises sulphides and simultaneously leaches gold and iron* → **Iron precipitation** → **Au recovered on activated carbon**

**May require oxygen plant for highly refractive ores.*

2. For arsenopyrite concentrates

Oxidises sulphides and simultaneously leaches gold and arsenic → **Arsenic/iron precipitation** → **Au recovered on activated carbon**

3. For double refractory concentrates (pyrite and/or arsenopyrite and carbon)

Arsenopyrite oxidation and leach of arsenic → **Pyrite oxidation** → **Arsenic/iron precipitation** → **Carbon oxidation by roasting** → **Au leached using regenerated liquor** → **Au recovered on activated carbon**

Source: After INL

It is important to balance the cost of grinding with leach retention time and subsequent gold recovery.

7.6.1 Concentrates

Intec has been testing the IGP on concentrates ground to approximately 80% less than 70-100 microns and the amount of re-grinding required depends on the nature of the mineralisation and the level of its reactivity.

Liberation of gold will typically improve with a finer grind size, however, associated costs will also increase (e.g. electricity, grinding medium) and losses of gold in fine grained 'slimes' to the tailings can be significant. As such, it is important to balance the cost of grinding with leach retention time and subsequent gold recovery.

Intec has been achieving acceptable results for arsenopyrite concentrates re-ground to 80% less than 30-40 microns.

The necessary grind for pyrite concentrates varies and although a highly reactive example may achieve satisfactory results as for arsenopyrite, more refractory (i.e. un-reactive) concentrates may require fine or even ultra-fine grinding.

Fine and ultra fine grinding will add to operating costs, and this is one of the reasons that Intec proposes to apply the IGP to arsenopyrite concentrates, which typically require less grinding and therefore offer the best cost savings against existing alternatives.

7.6.2 Leaching

The main advantages of the IGP are evident in the leaching stage, when the halide-based solution is typically able to oxidise the refractory minerals and simultaneously dissolve the gold.

The application of the IGP to pyrite, arsenopyrite and double refractory concentrates is discussed in more detail below.

7.6.3 Impurities

Another advantages of the IGP is that it is able to treat concentrates with impurities such as cadmium, manganese and magnesium. These can be precipitated from the regenerated cupric solution (i.e. the solution from which the gold has been removed), with the resulting purified brine returned to the process (i.e. no wastage).

It is important to note that the IGP does not generate any liquid effluents or gaseous emissions and that all impurities are produced as solid by-products.

Once gold is removed, limestone is added to adjust the pH to 3.5, precipitating iron and copper, which are removed by filtration and recycled to the leach. Impurities such as cadmium, manganese and magnesium are then removed via slaked lime addition at pH 9 to form insoluble oxides that are recovered by filtration for disposal.

7.6.4 Gold recovery

After the leaching of the pyrite, arsenopyrite and double refractory concentrates (the latter would also be roasted*), the gold-bearing solution is passed through columns containing activated carbon onto which the gold is adsorbed, typically after 10-15 minutes as in conventional cyanide systems.

Metal has been extracted from a similar chemical matrix to the IGP by the nickel industry for many years and as therefore Intec believes that scaling up the IGP to pilot plant scale and beyond will be relatively low risk.

*Roasting ore can be problematic as recoveries from the resulting calcine will depend on the roasting conditions, which differ for pyrite and arsenopyrite and make an expensive, two stage roast necessary for mixed ores.

By using the IGP to leach arsenic, iron and sulphur, any necessary roast becomes a simpler, one-stage process and the subsequent off-gas, clean up costs for As_2O_3 and SO_2 are also greatly reduced.

7.7 Economic advantages of the IGP

Roasting of ores and concentrates produces noxious off-gases (e.g. As_2O_3 and SO_2) and although the associated environmental permitting is already stringent, it seems likely to become more so going forward.

Therefore cost comparisons have only been carried out with the remaining viable alternatives, Geocoat, pressure oxidation (presox), bacterial oxidation (bacox).

Geocoat – bacterial oxidation in a heap leach of sized, flotation/gravity concentrate-coated rock (waste or ore)

Pressure oxidation – oxidation at high pressures and temperatures

Bacterial oxidation – oxidation by a bacterial leach, typically applied to ore or concentrate in an agitated tank

Characteristics of the competing refractory gold processing technologies:

Process	Leach liquor		Oxygen source	Temperature (°C)	Pressure (Atm.)	Retention time
	Primary	Secondary				
IGP	Chloride	None	Air or O_2	90-95	1	6-20 hours
Geocoat	Sulphate	Cyanide*	Air	Up to 70	1	30-60 days
Bacox	Sulphate	Cyanide*	Air	45-75	1	100-150 hours
Presox	Sulphate	Cyanide*	O_2	>200	>30	1-2 hours

**Via a conventional CIL/CIP treatment plant.* *Source: INL*

A cost comparison for an operation producing 50,000tpa of concentrate for processing was carried out by Toronto-based John R Goode & Associates (Geocoat , presox and bacox) and Intec shareholder HG Engineering (IGP).

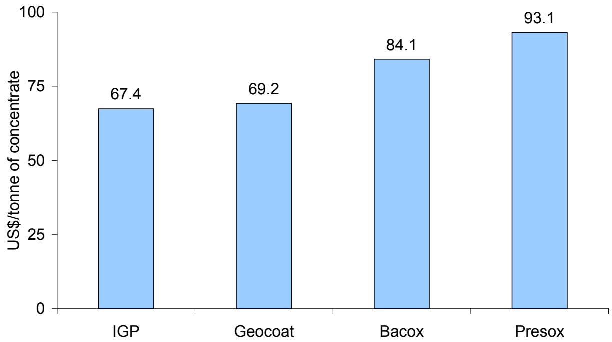
Both studies assumed North American location and cost structures and concentrate feeds were an average of 18 refractory gold concentrates*. Costings included construction and operation of oxidation and gold recovery circuits but not flotation and re-grind circuits, nor an oxygen plant, which may be required for the IGP in certain pyrite-rich concentrates.

**57.3g/t gold, 10.0 g/t silver, 20.2% sulphur, 7.9% arsenic, 0.4% antimony, 1.5% carbonate, 23.5% iron, 10.6% silicon, with 17.3% arsenopyrite and 31.4% pyrite.*

Operating costs for an IGP operation are estimated to be 3% less than for Geocoat, 20% less than for Bacox and nearly 30% less than for Presox.

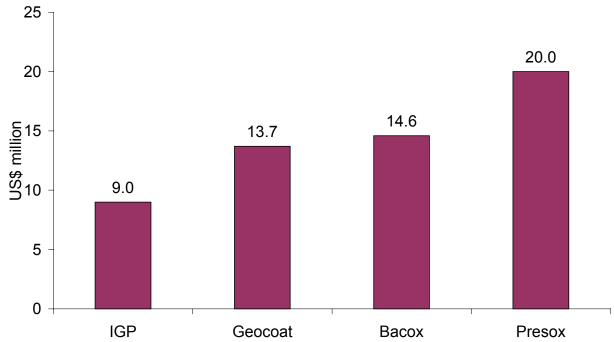
Even more significant are the capital cost savings, with an IGP facility estimated to be 34% cheaper than for Geocoat, 38% cheaper than for Bacox and more than half the price of a Presox alternative.

Figure 4: Operating costs for 50,000tpa operation



Source: INL

Figure 5: Capital costs for 50,000tpa operation



Source: INL

7.7.1 Case study

The economic advantages of the IGP can be demonstrated in the following illustrative example of a North American open pit operation, producing 50,000tpa of concentrate for on-site processing:

The IGP can be seen to offer significant cost savings and hence improved profitability when compared to pressure oxidation and bacterial oxidation (including Geocoat) alternatives.

In the example below the IGP renders the relatively high unit cost, low-tonnage operation economic, while the alternatives produce either significantly lower, or even negative returns.

	Operating costs		Capital costs		Gold	After tax NPV$_{10\%}$[2]	
	Mine & mill	Processing	Mine & mill	Processing	production		
	US$/tonne[1]	US$/t proc.	US$m	US$m	ounces	US$m	%
311,000tpa milled[3]							
50,000tpa concentrate							
Intec Gold Process	**30.0**	**67.4**	**30.0**	**9.0**	**82,500**	**23.5**	**100%**
Geocoat	30.0	69.2	30.0	13.7	82,500	19.7	84%
Bacterial oxidation	30.0	84.1	30.0	14.6	82,500	15.9	67%
Pressure oxidation	30.0	93.1	30.0	20.0	82,500	10.0	43%

	Sales revenue (A$000s)				Net profit royalty (A$000s)			
	3%		5%		10%		30%	
	P.a.[4]	NPV$_{10\%}$	P.a.[4]	NPV$_{10\%}$	P.a.[4]	NPV$_{10\%}$	P.a.[4]	NPV$_{10\%}$
Eg. of Intec royalty	742	4,561	1,237	7,601	570	3,501	1,709	10,503

[1]US$ per tonne mined/milled – assumes tonnes mined equals tonnes milled. [2]Assumes only gold is payable at 90% recovery over 10 years. *Source: INL and WHIS estimates*
[3]Assumes 57g/t gold in concentrate. [4]Annual average after-tax earnings

Intec will be looking to initially apply the IGP to small projects which have most of the gold held by arsenopyrite, given the cost advantages that its process will hold over alternatives.

7.8 Environmental advantages of the IGP

As well as offering significant economic advantages over existing processing alternatives, the IGP is also more environmentally friendly for a number of reasons:

- ***No cyanide*** – unlike in the conventional CIL/CIP plant.

  Disposal of cyanide has been a major headache for gold operations. It often must be destroyed using a suitable oxidant (e.g. hypochlorite) at considerable expense.

  In the IGP gold is leached into the chloride solution and adsorbed onto activated carbon columns, where it can be recovered by conventional elution or burning of carbon.

- ***By-product disposal*** – e.g. arsenic and sulphur.

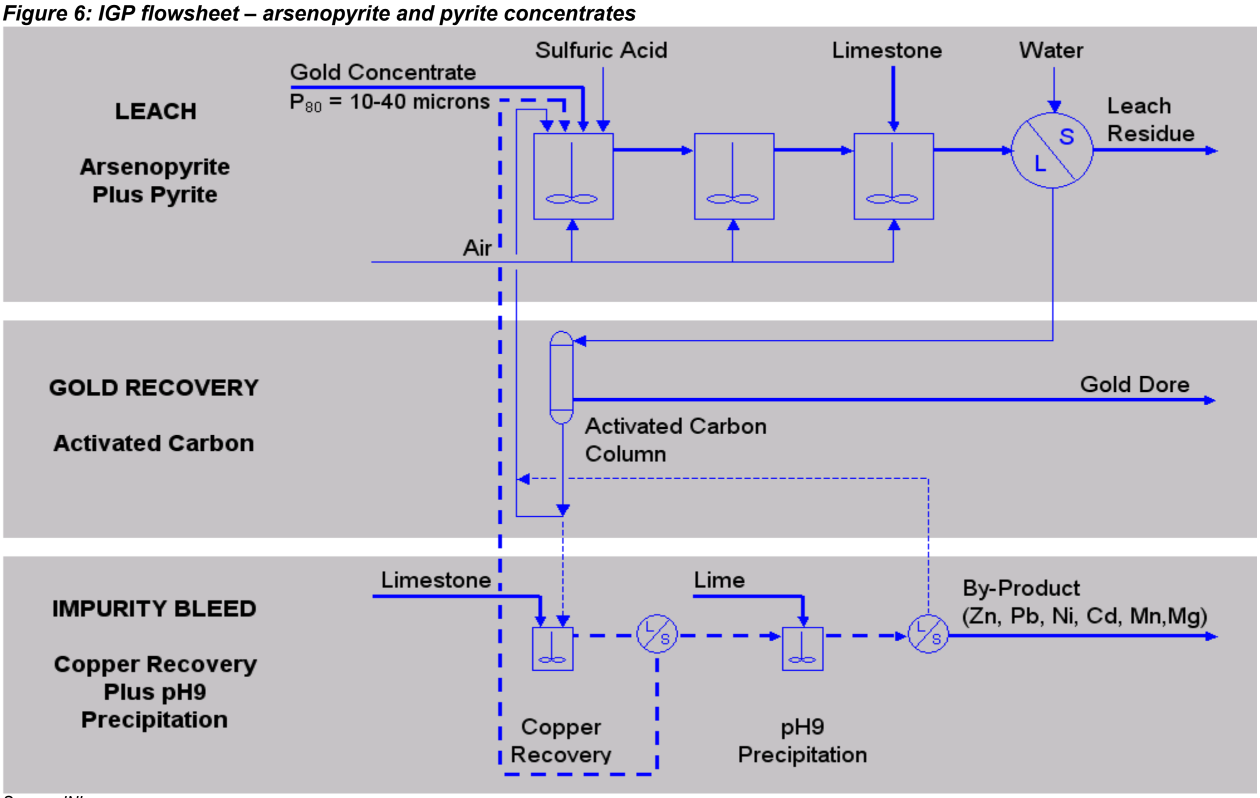
  Roasting creates toxic arsenic trioxide (As_20_3) which must be disposed of at considerable cost, however, the IGP creates the most stable form of arsenic, crystalline ferric-arsenate ($FeAs0_4$).

- ***No unstable sulphate residues***

  The IGP creates elemental sulphur and gypsum when oxidising arsenopyrite and pyrite, which are more stable than the residues of pressure leaching and especially bacterial leaching.

7.9 IGP flowsheet – arsenopyrite and pyrite concentrates

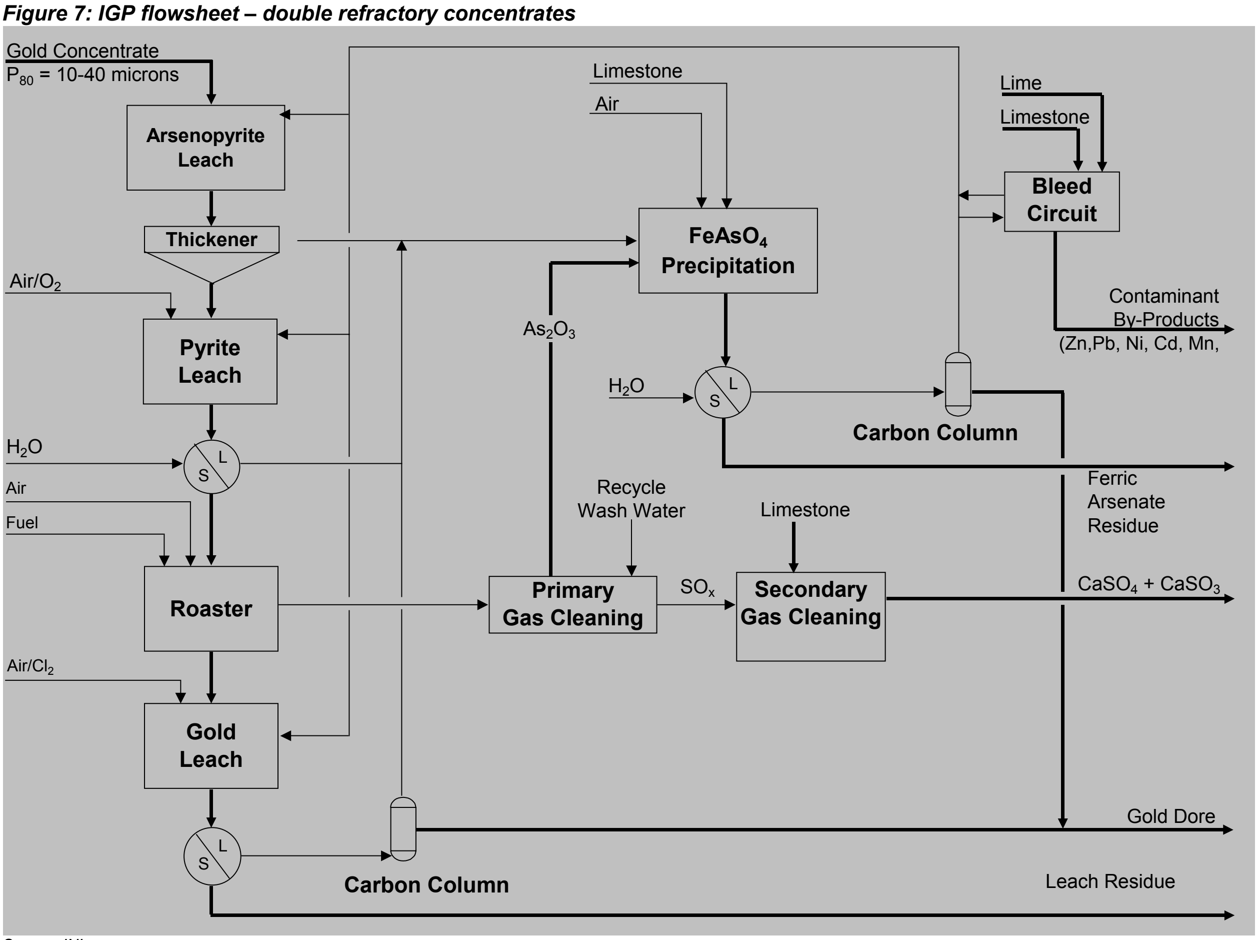
Figure 6: IGP flowsheet – arsenopyrite and pyrite concentrates



Source: INL

7.10 IGP flowsheet – double refractory concentrates

Figure 7: IGP flowsheet – double refractory concentrates



Source: INL

7.11 Treating arsenopyrite (FeAsS) concentrates with the IGP

1) Gold is locked within arsenopyrite and as such the lattice must be broken through oxidation to allow it to be leached as follows:

$FeAsS + 2O_2 \rightarrow FeAsO_4 + S$

The oxidation process (oxygen usually as air at atmospheric pressure) actually consists of a number of steps:

2) The oxygen initially generates a soluble oxidant in the form of a cupric ion (Cu^{2+}):

$2Cu^{+} + 1/2O_2 + 2H^{+} \rightarrow 2Cu^{2+} + H_2O$

3) The cupric ion then oxidises the arsenopyrite at 90-95°C:

$FeAsS + 7Cu^{2+} + 4H_2O \rightarrow H_3AsO_4 + Fe^{2+} + S + 5H^{+} + 7Cu^{+}$

4) The ferrous (Fe^{2+}) and cuprous (Cu^{+}) products are then oxidised further as in equation 2) above and:

$Cu^{2+} + Fe^{2+} \rightarrow Cu^{+} + Fe^{3+}$

5) In the presence of the ferric ion (Fe^{3+}) the arsenic acid (H_3AsO_4) produced in equation 3) above forms insoluble ferric arsenate, typically in a crystalline, environmentally stable form:

$H_3AsO_4 + Fe^{3+} \rightarrow FeAsO_4 + 3H^{+}$

6) The Cu^{2+}/Cu^{+} couple, with assistance from the Fe^{3+}/Fe^{2+} couple, creates a very strong oxidising environment that allows dissolution of gold:

$3Cu^{2+} + Au + 4Cl^{-} \rightarrow AuCl^{4-} + 3Cu^{+}$

7.12 Treating pyrite (FeS) concentrates with the IGP

7) Pyrite is oxidised in the IGP as for arsenopyrite above, according to the following overall reaction:

$4FeS_2 + 15O_2 + 2H_2O \rightarrow 8SO_4^{2-} + 4Fe^{3+} + 4H^{+}$

N.B. Pyritic sulphur is oxidised to sulphate, rather than to its elemental state as in the case of arsenopyrite.

Pyrite is typically more refractory than arsenopyrite, although contamination of the former's lattice by arsenic (product sometimes termed arsenical pyrite) may cause favourable variations.

Highly refractory pyrite ores may require pure oxygen rather than air to reach the necessary oxidation potential.

8) The oxygen initially generates Cu^{2+} according to reaction 2), which then oxidises the pyrite:

$FeS_2 + Cu^{2+} + 4H_2O \rightarrow SO_4^{2-} + Fe^{2+} + 8H^{+} + 7Cu^{+}$

9) The Fe^{2+} ions are oxidised as in reactions 2) and 4) above, precipitating ferric sulphate as haematite and gypsum ($CaSO_4$) by the addition of limestone at a pH of around 1-1.5 as follows:

$SO_4^{2-} + 2Fe^{3+} + 2H^{+} + 4CaCO_3 \rightarrow Fe2O_3 + 4CaSO_4 + 4CO_2 + H_2O$

The pH must be controlled in order to prevent loss to the leach residue of cupric (Cu^{2+}) copper.

7.13 Treating double refractory concentrates with the IGP

At low carbon grades, typically less than 3%, recoveries can potentially be improved by adding organic compounds to inhibit gold adsorption.

However, when carbon content exceeds 3-5%, "preg-robbing" becomes an issue, whereby carbon removes gold from the leachate. The usual option is to roast the ore, however, this can be problematic as recoveries from the resulting calcine will depend on the roasting conditions, which differ for pyrite and arsenopyrite and make an expensive, two stage roast necessary for mixed ores.

By using the IGP to leach arsenic, iron and sulphur, any necessary roast becomes a simpler, one-stage process and the subsequent off-gas, clean up costs for As_2O_3 and SO_2 are also greatly reduced.

The IGP treat double refractory concentrates as follows:

a) Concentrate fed to arsenic leach, arsenopyrite oxidised as in equation 3) above, using cupric (CU^{2+}) solution generated during arsenic precipitation. Leaches at 90-95°C at a retention time of 3-4 hours.

b) After leaching, the oxidised slurry is separated in a thickener, with the arsenic-bearing thickener overflow sent to arsenic precipitation (see below) and the underflow send to the pyrite leach.

c) The pyrite is oxidised as in equation 8) above, using some of the liquor from arsenic precipitation, however, the acid generated from sulphate formation is not neutralised as in equation 9), but is used to maintain all leached iron in soluble form. The high oxidation potential of the liquor is such that any residual arsenopyrite is oxidised and the high acidity maintains the resulting arsenate in solution.

   Pyrite leach retention time ranges from 6-20 hours and is a function of pyrite grade and reactivity. Once the leach is completed, the solids are largely depleted of iron, arsenic and to a lesser extent sulphur (arsenopyrite sulphur is only oxidised to the elemental state and is not further oxidised during the pyrite leach). The pyrite-leach slurry is then sent directly to pressure filtration, with the cupric/ferric solution directed to arsenic precipitation. The solids are washed and sent to the subsequent roasting operation.

d) The two leach liquors are combined and through the addition of air, arsenic is precipitated and the cupric solution regenerated for return to the arsenic leach according to equations 2), 3) and 4). Excess acid is neutralised with limestone, according to equation 9), only once air addition is complete, thus maintaining a high iron background during iron arsenate formation which further enhances its environmental stability.

e) The precipitated solids are then separated by pressure filtration and washed prior to discharge. The filtrate represents the regenerated solution for leaching operations and is firstly passed through carbon columns to adsorb any gold that remained after leaching.

f) The separated precipitate is then roasted in order to oxidise the carbon.

g) The resulting calcine is now suitable for the leaching of gold using the same regenerated leach liquor used for both the arsenopyrite and pyrite leaches described in a) and c).

h) The leached gold is recovered from the liquor on activated carbon after leach residue filtration and washing, with barren liquor sent to the arsenic precipitation circuit.

W.H.I. SECURITIES PTY LTD

David Sutton *– dsutton@whisecurities.com.au – Chairman (Sydney)*
Barry Dawes *– bdawes@whisecurities.com.au – Managing Director (Sydney)*

Peter Le Messurier *– whisecurities@firstavenue.com.au – Broker (Adelaide)*
Rob Towner *– rtowner@ozemail.com.au – Broker (Perth)*

Tony Lethlean *– alethlean@bigpond.com.au – Advisor (Bendigo)*

Duncan Hay *– djhay@whisecurities.com.au – Analyst (Sydney)*
Ben Dickie *– bdickie@whisecurities.com.au – Analyst (Sydney)*

Alice Le Messurier *– alemessurier@whisecurities.com.au – Administration (Sydney)*
Amanda Kuti *– akuti@whisecurities.com.au – Administration (Sydney)*

Sydney Office *– Tel: (61 2) 9222 9111 Fax: (61 2) 9221 9680*
Adelaide Office *– Tel: (61 8) 8267 5533 Fax: (61 8) 8267 5577*
Perth Office *– Tel: (61 8) 9202 1855 Fax: (61 8) 9325 7190*

DISCLAIMER