Appendix 2

Intrusion-related Gold Systems. A brief summary by Bruce Pertzel.

The new frontier for new discoveries of significant large gold deposits - Intrusive-related gold systems [IRGS] – a Brief Summary of Characteristics and Identifiable Features (relevant to greenfields exploration)

The classification of Intrusion-related gold systems (IRGS) is a relatively recent development. Hart (2005) points out that no serious and comprehensive research of the genesis of gold deposits commenced until 1980 when the price of gold increased significantly. Baker (2003) cites the progression of classification of gold deposits related to magmatic rocks as commencing with the term porphyry gold deposits (after the usage of porphyry copper deposits) in 1992 by Hollister. This ignores the fact that Sillitoe (1979) had earlier introduced the concept of a porphyry gold deposit style. The next variation in the classification was used in 1995 by Bakker - Fort Knox Style and since then the progression continued with Intrusive Gold (Newberry et al 1995); Plutonic Gold (McCoy et al, 1997); Intrusion-related Gold (Thompson et al, 1999 and Granitoid Gold (Goldfarb et al, 1999).

The generally accepted classification term is now Intrusion-related Gold Systems (IRGS).

It is reasonable to suggest that there remains an amount of confusion over the classification and many deposits might be included in such a classification without warranting such. However classifications are only convenient pigeon holes commonly used in geology and it should be remembered that each ore deposit has its own specific and unique characteristics and not all deposits exhibit all characteristics of any particular classification. If this was to be the case all significant deposits would have already been discovered as it would have been quite procedural to apply routine techniques to their discovery.

The classification was developed initially to describe gold-only porphyry deposits and as such most examples were limited to what could now be described as oxidised IRGS deposits and their distribution restricted to the Circum-Pacific Island Arc settings.

The subsequent and current classification includes a new class including intrusion-related gold mineralisation in regions lacking copper but known for tin and tungsten deposits and having an associated Bi-Te-As-Mo-Sb metal tenor (Hart, 2005).

Hence the classification includes both the I-Type granitoid intrusions which are in an oxidised state (and with which porphyry-copper systems are commonly associated) and S-Type Granitoids which are in a reduced state (and with which tin-tungsten and bismuth-telluride-arsenic-antimony-molybdenum mineralisation is associated). This latter type was developed using the large recently discovered gold deposits, such as Fort Knox, Shotgun, Dublin Gulch and Donlin Creek in the Tintina Gold Province that encompasses central Alaska (USA) and the Yukon (Canada) in North America, as type examples. This provides a broader geographical setting for IRGS deposits than that initially thought to be restricted to porphyry-copper provinces.

The classification is broad but complex and there is much debate in the technical literature about the assignment of various, previously classified orogenic gold deposits as being IRGS types.

A simplistic view is that there are two broad styles of IRGS gold deposits.

1. Those that occur in the copper-poor or absent portions of conventional island arc generated porphyry copper systems, associated with oxidised-state magmatic complexes, as porphyry gold deposits
2. Those that occur in base-metal poor or absent portions of Sn-W mineralised magmas associated with reduced-state magmatic complexes as gold-bismuth-telluride or gold-arsenic-molybdenum-antimony systems.

However the IRGS classification in current use refers to an incoherent group of deposits with wide-ranging characteristics, granitoid associations and tectonic settings (Hart, 2005).

The characteristics of the second type of IRGS deposits, using the well-studied examples of the Tintina Gold Province, can be summarised as follows:

1. Intermediate to felsic composition intrusion near the ilmenite-magnetite series boundary
2. Carbonic hydrothermal fluids
3. Gold combined with elevated either Bi, W, As, Mo, Te and/or Sb and low base metal concentrations
4. Usually low sulphide content (less than 5%) with arsenopyrite, pyrrhotite, pyrite but no magnetite or ilmenite
5. Restricted areal extent and weak hydrothermal alteration
6. Tectonic setting well away from convergent plate boundaries (Continental setting)
7. Location in magmatic provinces best known for tin and tungsten mineralisation

The following features could be used to provide evidence of intrusion related origins of gold mineralisation:

1. Tectonic Setting – preferred host strata include relatively deep water, reducing sediments and metasediments. Intrusions emplaced into old continent margins behind active plate margins
2. Metal Zonations – temperature dependent and concentric zones up to a few kilometres out from the pluton margin or just beyond the thermal aureole. Pluton - proximal Au has Bi, Te association; W associated aureole mineralisation will have As or Sb association; distal mineralisation may be related to Ag-Pb-Zn
3. Diversity of Deposits – several different styles possible; intrusion and/or country rock hosted – skarns, replacements, disseminations, stockworks and veins: gold mineralisation characterised by wide range of grades ; large tonnages present have a range of 0.8 to 1.5 g/t Au (e.g. Fort Knox)
4. Sheeted Veins – this is the most distinctive style in reduced IRGS type; sheeted arrays of parallel, low-sulphide, single-stage quartz veins over 10s to 100s of metres preferentially situated in the pluton's cupola
5. Pluton Features – indicative of hydrothermal fluid generation; characteristic textures – porphyritic, presence of aplite and or pegmatite dykes, greisen alteration and zonation features
6. Redox State – felsic, ilmenite-series plutons; no magnetite therefore low magnetic susceptibility and low aeromagnetic response; ferric:ferrous ratios less than 0.3

7. Timing – mineralisation and associated causative pluton are coeval (events are within 2 million years)

IRGS gold deposits are commonly confused with orogenic gold deposits with which they share characteristics 1 to 4 above.

The Table below provides a summary of some major IRGS classified deposits, their metal endowment, grade and location.

Deposit	Country	Region	District	M ozs Au **	Grade g/t
Fort Knox	USA	Alaska	Tintina	5.7	0.42
Donlin Creek	USA	Alaska	Tintina	32	2.91
Dublin Gulch	Canada	Yukon	Tintina	4.8	0.68
Pogo	USA	Alaska	Tintina	5.6	12.5
Shotgun	USA	Alaska	Tintina	1.1	0.93
Kidston	Australia	Queensland	Lachlan Fold Belt	4.1	2.08
Timbarra	Australia	New South Wales	Lachlan Fold Belt	0.396	0.78
Cadia-Ridgeway	Australia	New South Wales	Lachlan Fold Belt	43.2	1.3
Wonga	Australia	Victoria	Lachlan Fold Belt (Stawell)	0.35	3.96
Martins Shaft	Australia	New South Wales	Lachlan Fold Belt (Uralla Goldfield)	0.5-2.0#	
McCraes	New Zealand	Otago		3.9	1.4
Sams Creek	New Zealand	Westland	Reefton	1.02	1.71
Chepak	Russia	Magadan	Central Kolyma	0.8	7.7
Malysh (Dubach)	Russia	Magadan	Central Kolyma	0.9	4
Netchen-Khaya	Russia	Magadan	Tenka	0.3	5
Chistoye	Russia	Magadan		0.4	4
Shkolnoye Vein N6	Russia	Magadan	Tenka	0.6	38

Notes:
 # exploration target no JORC Resource
*** Total metal endowment in deposit, unconstrained by mining considerations*

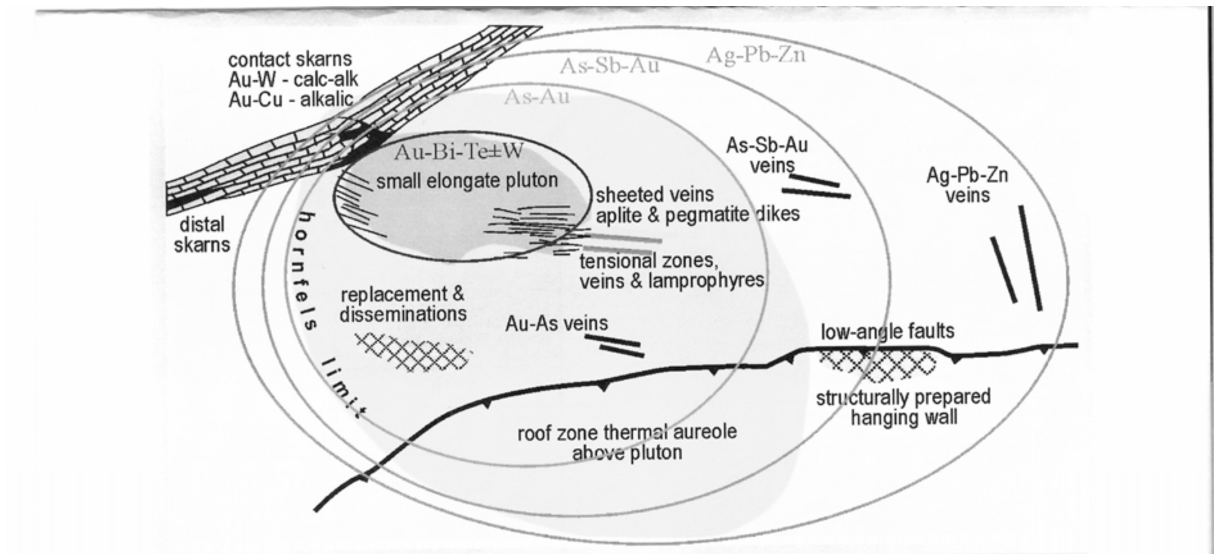

Figure 2. General plan model of intrusion-related gold systems from the Tintina Gold Province. Note the wide range of mineralization styles and geochemical variations that vary predictably outward from a central pluton (modified from Hart et al., 2002).

IRGS Reduced Model - taken from Hart (2005) – FOR TINTINA GOLD PROVINCE DEPOSITS, NORTH AMERICA (ALASKA, USA AND YUKON, CANADA)

DISCUSSION

***Exploration for and the development of mineral deposits can be made more effective as the geological processes controlling their formation are better understood* (Malone, 2012)**

The recognition of IRGS deposits in the Tasman terrane of Eastern Australia is of great significance for mineral explorers holding exploration tenements in the States of Queensland, New South Wales, Victoria and Tasmania.

Sovereign Gold Company Limited, an ASX-listed junior explorer claims a new IRGS discovery at Martins Shaft, a principal prospect in the Uralla Goldfield, SW of Armadale in the New England sector of the Lachlan Fold Belt. (Company announcement to the ASX, October, 2012).

The recognition of the large Cadia-Ridgeway Gold (Copper)Deposits in Central NSW and the Wonga gold deposit at Stawell (a site mined continuously for 29 years) as having IRGS affinities highlights the potential for similar deposits to be found using judicious application of the IRGS features to contemporary exploration programs. Potential for new gold deposit discoveries in the Palaeozoic miogeosynclinal sedimentary sequences of the Tasman Geosyncline (on both sides of the Tasman) – a province known for its orogenic style turbidite-hosted gold deposits such as Bendigo, Ballarat and McCraes – is further enhanced by the recognition of IRGS deposits in this terrane.

Blevin (date unknown) has documented Eastern Australian IRGS deposits for Eastern Australia.

They are listed below with a summary of notable and diagnostic features documented by Blevin.

Examples of IRGS Deposits in Eastern Australia (after Blevin)

Deposit	Contained Au**	Grade g/t Au	Setting	Style	Host Rock	Intrusive Suite
Queensland						
Kidston	4.1 M	2.08	High-level, subvolcanic	Breccia	rhyolites	Lochaber-Bagstowe Complex
Red Dome	0.82 M	2.00	High-level, subvolcanic	Breccias, porphyries	rhyolites	Ootann Supersuite
New South Wales						
Timbarra	0.42 M	0.95	Pluton, marginal	Disseminated	Granite	Moonbi Supersuite
Lucky Draw			Pluton, marginal	Skarns	Metasediments	Burraga Granite
Majors Creek-Braidwood			Pluton roof zone	Veins, disseminations	Granites and country rock	Braidwood Granodiorite
Dargues Reef	0.38 M	7.24	Pluton	Lodes	Granite	Braidwood Granodiorite
Victoria						
Wonga	0.35 M	3.96			Granite	Stawell Granite
Maldon					Granite	Harcourt Granite
Mount Piper			High-level, subvolcanic			
Myrtle Creek						
Malmsbury						
Woods Point Dyke Swarm				Lodes	Basic Dykes	Woods Point Dyke Swarm

***Notes*:**

*** Total metal endowment in deposit, unconstrained by mining considerations*

REFERENCES

The following technical papers were referred to (and are cited where appropriate) in compiling this brief summary.

Baker, T (2003) *Intrusion-Related Gold Systems, Classification, Characteristics and Exploration*. ERGU James Cook University, Australia (PowerPoint presentation).

Blevin, Phillip (????) *Intrusion Related Gold Deposits*. Geoscience Australia, www.australianminesatlas.gov.au

Goryachev, N and Yakubchuk, A (2008) *Gold Deposits of the Magadan Region, NE Russia: Yesterday, Today and Tomorrow.* SEG Newsletter, July 2008 Vol.74

Hart, C J R (2005) *Classifying, Distinguishing and Exploring for Intrusion-Related Gold Systems.* Canadian Institute of Mining – Geological Society "The Gangue" Issue 87, October 2005.

Mustard, Roger (2001) *Granite-hosted gold mineralization at Timbarra, northern New South Wales, Australia.* Mineralium Deposita, 36 (6). pp. 542-562.

Websites:

www.newcrest.com.au

www.modresources.co

m.au

www.portergeo.com.au

www.oceanagold.com

www.sovereigngold.com

.au www.vitgold.com