YANDAN GOLD DEPOSIT, DRUMMOND BASIN, QUEENSLAND

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LOCATION

The Yandan Au deposit is located in North Queensland, 140 km SSE of Charters Towers and 230 km W of Mackay (Figure 1) at 21°18'S, 146°58'E; Buchanan 1:250 000 map sheet SF55-06.

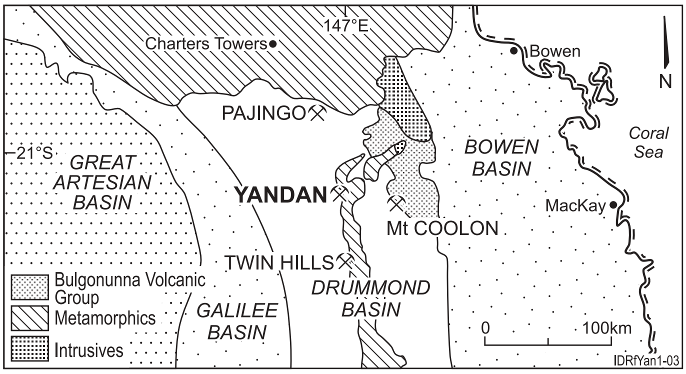

Figure 1. Location and regional geology.

DISCOVERY HISTORY

Prior to exploration by WMC in 1986, the only exploration in the area had been broad-spaced, regional stream sediment surveys (analysed by the bulk cyanide leach method) by at least two exploration companies (unreported data). Geochemical exploration by WMC was in two phases. The first was a 352 sample stream sediment survey using the <200 µm size fraction. Of two samples taken near Yandan, one was anomalous (Au 34 ppb, As 30 ppm and Sb 5 ppm). It represented a 0.4 km^2 catchment between Main and South Hills, approximately 500 m E of the main Yandan ore zone (Figure 2A). The whole of a 500 m reconnaissance soil traverse across East Hill (assumed to be the source of the anomaly) was anomalous (Figures 2A and 2B). The highest Au values were at the western end of the line close, to Main Hill. East Hill had a strong As anomaly (320 ppm).

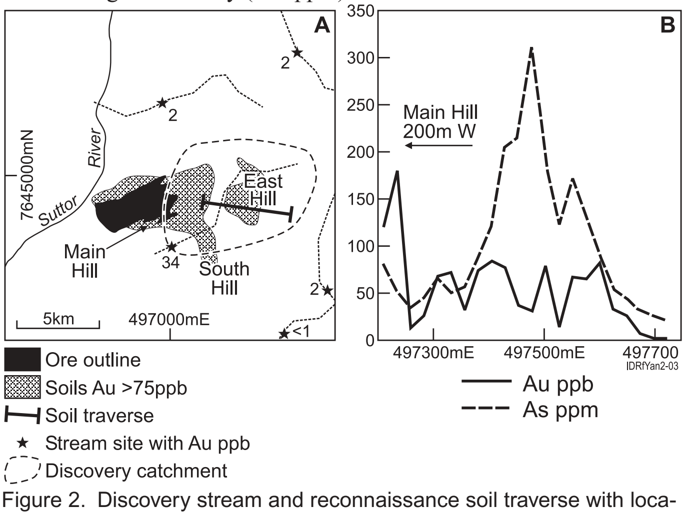

Figure 2. Discovery stream and reconnaissance soil traverse with location of the mineralization and the extent of the soil anomaly (A) and the discovery Au and As soil traverse (B).

Detailed stream sampling followed in the Yandan area with most of the 18 samples being anomalous (>8 ppb Au). The sampling generated a strong coincident Au-As anomaly supported by Hg and Tl within an area of 0.8 km^2. Rock chip sampling of Main Hill (two samples) and East Hill (23 samples) gave 20 samples above the detection limit (20 ppb Au) with two samples containing quartz veining, which is more apparent on East Hill, having >1000 ppb Au. Soil sampling on a 100 x 25 m grid covering 1.5 x 1 km followed. The best anomaly, with a maximum of 1400 ppb Au, was from Main Hill, associated with a zone of siliceous alteration. The soil anomaly was tested by reconnaissance RC drilling of sixteen holes (985 m) in July 1987, resulting in discovery of the Yandan deposit.

PHYSICAL FEATURES AND ENVIRONMENT

Yandan is located in the S part of the upper catchment of the Burdekin River and has a dry savanna climate. The average annual rainfall is 585 mm, mostly between November and March. The average daily temperature range is 20-35°C in summer and 6-22°C in winter.

The Suttor River, which forms the western boundary of the project area, is an ephemeral, braided stream within a broad, black soil plain. The immediate project area has four small hills of up to 30 m relief. The four hills were named East, Main, South and Far South hills. Outcrop is generally restricted to the hill crests.

As a result of extensive clearing in the 1980s, the Yandan area is now almost devoid of original vegetation. The low open brigalow (*Acacia harpophylla*) forests and coolibah (*Eucalyptus microtheca*) woodlands were virtually destroyed. There are minor remnants on the top of East Hill.

GEOLOGICAL SETTING

Regional geology

The Yandan deposit lies in the northern part of the Drummond Basin (Figure 1) within the Devonian-Carboniferous sediments and volcanics of the St Anns Formation. The basement to these sediments is the Ordovician metamorphics of the Anakie Inlier. Within the Drummond Basin, Olgers (1972) recognized three cycles of sedimentation and volcanism. Near Yandan, only the first cycle is represented by the basal St Anns Formation, capped by the Llanarth Volcanics (Figure 3). Sedimentation in the Drummond Basin terminated in the Early Carboniferous. The Drummond Basin was, in turn, overlain unconformably by Permian and Triassic sediments of the Galilee and Bowen Basins (Figure 1) and intruded by numerous late Carboniferous, Permian and Tertiary rocks. Extensive sheets of Tertiary sediments of the Campaspe and Suttor formations obscure much of the Drummond Basin N and W of Mt Coolon.

Local geology

The stratigraphy and structure of the immediate Yandan area are summarized in Figure 4A. The epithermal Yandan mineralization is largely stratabound, controlled by faults, within the Devonian-Carboniferous sediments of the St Anns Formation, near the base of the Drummond Basin sequence.

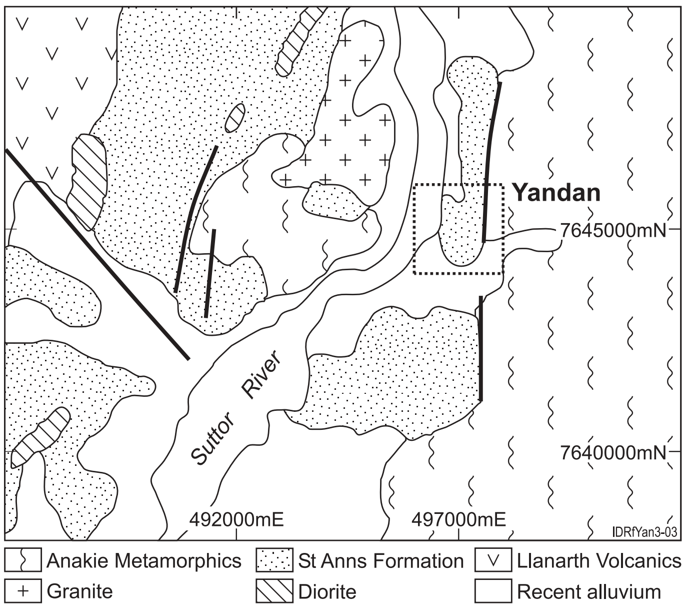

Figure 3. Local geological setting of the Yandan Deposit showing the location of the detailed study area of Figures 2 and 4.

Local mapping has informally divided the St. Anns Formation into three members (Sharpe, 1991) from base to top; (i) Lower St. Anns, (ii) Yandan Andesite, (iii)Yandan Limestone. The Yandan Andesite Member is subdivided into four units: (i) Yandan Andesite; 150 m of interbedded andesitic flows, volcanic breccias and agglomerates, lithic and lapilli tuffs, pyroclastics and epiclastics. The andesite contains only minor uneconomic vein mineralization. This unit is locally capped by a layered sinter deposit.

(ii) Lower Host, (iii) Main Host - main mineralized unit and (iv) Upper Host.

These three units show a gradual upward fining from conglomerates and gravels through weakly ordered sands to silts. All these sediments are of epiclastic and tuffaceous lacustrine or fluviatile origin. The host sediments are capped unconformably by the Yandan Limestone. Near Yandan, the volcanic rocks and sediments strike ENE and dip gently (5-15°) NNW. They are separated from the metamorphics of the Anakie Inlier to the E by the N-striking normal East Yandan Fault Zone (Figure 4A).

Two sets of faults disrupt the sediments. The main fault trends ENE, sub-parallel to bedding. The Yandan Fault Zone and South Yandan Fault combine to create an E-trending horst. The main mineralization is confined to the northern side of this horst. The second set of faults strikes nearly N and the faults have a minor W-side-down movement. The most notable of these is the Yandan Creek Fault, which limits the Yandan mineralization in the W.

REGOLITH

There are two major soil types (Chenoweth, 1995) near the Yandan deposit. Lithosols in areas of outcrop and subcrop, are thin and very stony and are generally light grey to buff. In areas away from outcrop there are extensive sandy to silty loams. These soils lack stony fragments, are deep-red to deep-brown and are very immature, as new alluvium is deposited on them every time the Yandan Creek and/or the Suttor River flood.

MINERALIZATION

The main Au mineralization at Yandan is broadly stratabound and disseminated within the sediments of the Yandan Host Unit. The alteration and rock textures indicate epithermal mineralization. Although the mineralization is largely disseminated, the spatial distribution of zones of brecciation, veining and silicification and the concentration of Au leave no doubt that the E-trending feeder zone was the source of auriferous, mineralizing solutions.

Broadly, the mineralization is surrounded by a prominent alteration zone. Remote from mineralization, both laterally and vertically, the host sediments have been altered to a low rank illite-celadonite mixed layer clay assemblage. This grades into a two-stage bleaching around the ore of quartz, illite, K-feldspar and pyrite, overprinted by intense kaolin alteration (Sharpe, 1991). At the top of the mineralization is intense silica flooding of the sediments and, consequently, attenuation of ore grade. Within the andesite at East Hill, the alteration is similar, but mineralization is restricted to discrete quartz-adularia veins within a zone of hydrothermal brecciation.

Gold within the main Yandan deposit is very fine-grained (50% <4.5 µm), has a very low Ag content (about 900 fine). In contrast, the Au of the East Hill veins is said to be typically coarser and has a high Ag content (500-600 fine).

Prior to mining, Yandan had a mineable ore reserve of 4.72 Mt at 2 g/t Au and an additional 3.44 Mt of heap leach ore grading 0.46 g/t Au (Maxey and Ryan, 1993). Yandan was mined by Ross Mining in 1997-2001.

REGOLITH EXPRESSION

Stream sediment

The Yandan deposit is associated with a strong coincident Au-As anomaly 0.8 km^2 in area. Robust thresholds (<200 µm fraction) are 8 ppb for Au and 30 ppm for As. Values peak at 160 ppb (Au), 215 ppm (As), 290 ppb (Hg) and 32 ppm (Sb) (Figures 4B and 4C).

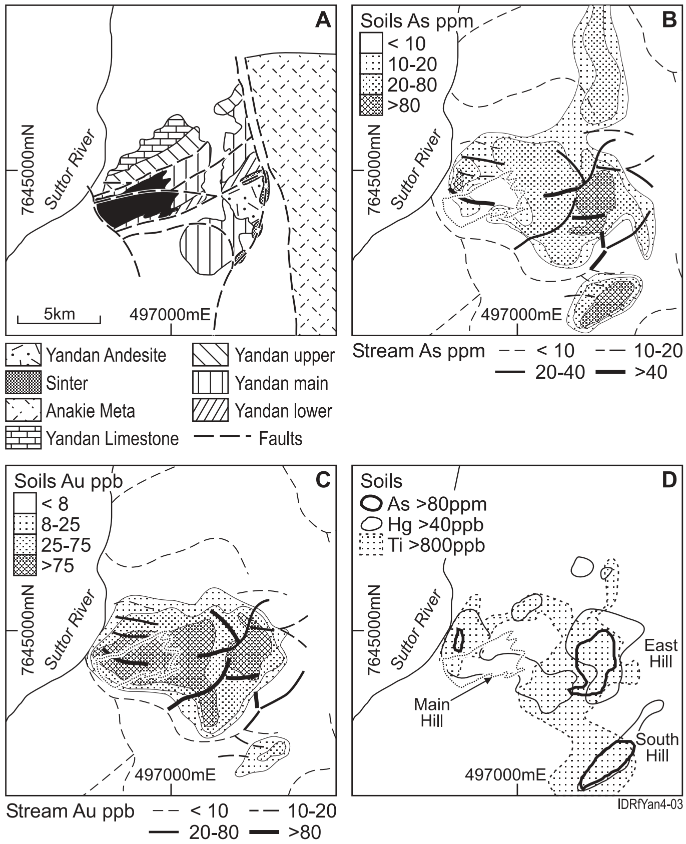

Figure 4. Detailed geology around the Yandan Deposit (A) after Sharpe (1991), detailed Au soil and stream sediment geochemistry (B), detailed As soil and stream sediment geochemistry (C), relationship between Au, As, Hg and Tl in soil (D).

The area surrounded by the 8 ppb contour for Au in soils indicates that dispersion from the mineralization is minimal. Stream sediment sampling is optimal at a density of 2 per km^2. A total of 19 orientation samples of active stream sediments were collected around Yandan. At each site:-

1) 3 kg of <6 mm active sediment were sieved into the size fractions 6000-2000 µm, 2000-400 µm, 400-200 µm, 200-125 µm, 125-75 µm, and <75 µm. The dominant fraction in the stream sediments is 2000-400 µm comprising 48% of the whole; the <75 µm fraction comprises only about 0.3% of the average sample. Gold was determined on 30 g aliquots of these fractions by graphite furnace AAS after aqua regia digestion. Other elements were determined following HNO_3-$HClO_4$ digestion.

TABLE 1
STATISTICS FROM STREAM SEDIMENT ORIENTATION

Element	Size/method	Au ppb Max	Percentiles 50th	97.5th	Percentile Ratio 97.5/50
Au	125-75 µm	201	3	49	16.3
Au	200-125 µm	137	3	35	11.6
Au	400-200 µm	168	3	55	18.3
Au	2 mm-400 µm	250	4	136	34
Au	6-2 mm	580	5	260	52
Au	BLEG	18	0.5	6.4	12.8
As	125-75 µm	60	8	60	7.5
As	200-125 µm	115	11	110	10.0
As	400-200 µm	165	10	135	13.5
As	2mm-400 µm	550	12	180	15
As	6-2 mm	310	15	235	15.6
Sb	125-75 µm	17	1	6	6.0
Sb	200-125 µm	18	2	6	3.0
Sb	400-200 µm	30	1	8	8.0
Sb	2 mm-400 µm	96	-1	7	7.0
Sb	6-2 mm	52	-1	13	13

Au by graphite furnace AAS after aqua regia digestion
As, Sb by AAS after HNO_3-$HClO_4$ digestion

2) 5 kg of <2 mm were analysed for Au by BLEG after 24 hours of leaching in dilute NaCN solution (detection limit 0.05ppb).

The statistics for the key elements from the size fractions are given in Table 1. The ratio of the 97.5:50 percentiles is a good measure of contrast; ratios >4 represent good contrast. Gold commonly gives ratios >10 and this is the case for this data set. The contrasts are good for all fractions but are greatest in the optimum 6000-2000 µm fraction. Dispersion trains (Chenoweth, 1995) were determined for the stream draining the centre of the deposit. Dispersion of Au in the 6000-2000 µm fraction extends for 1650 m downstream. However, there is a marked decrease beyond about 900 m downstream. The dispersion train for Au by BLEG is about 1100 m. Arsenic is dispersed 900 m. Molybdenum, Tl, Hg and Se, while not primary indicators, can be useful but Cu Pb and Zn are unhelpful.

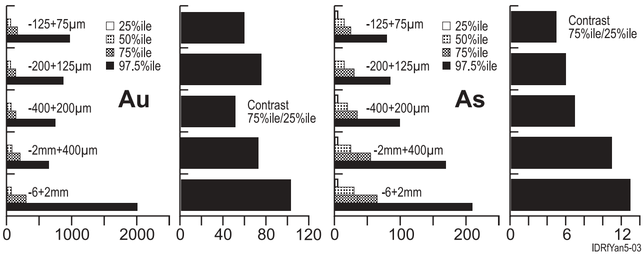

Figure 5. Distribution and contrast for Au in soil fractions (A) and distribution and contrast for As in soil fractions (B).

Soil

An extensive area around Yandan was sampled on a 200x25 m grid using the <200 µm fraction. The relationship between the soils and detailed streams is shown for Au and As in Figures 4B and 4C. Similar areas are defined above 8 ppb Au and 20 ppm As. At higher thresholds (75 ppb Au and 80 ppm As) the pattern changes. Gold and As are coincident at East Hill, but As is peripheral to Au at the main Yandan deposit. Figure 4D depicts the relationships of Au, As, Hg and Tl. The latter two elements are clearly associated with the mineralized system, but the peaks are again adjacent to Au at Main Hill and largely coincident at East Hill.

A multi-fraction orientation traverse was run across the soil anomaly. The results for Au and As for the 5 size fractions are summarised in Figures 5A and 5B. These diagrams depict the element variation as a function of percentiles, which clearly shows the higher Au and As contents of the 6000-2000 µm fraction and the increasing contrast with increase in particle size for both elements. The 75:25 percentile ratio has been used to establish contrast here as about 60% of the samples are anomalous.

The main mineralized zone at Yandan is 500 x 200 m which, combined with peripheral weaker mineralized zones, has resulted in a geochemical footprint in soils and stream sediments of 1000 x 800 m. All size fractions are effective, but the contrast is best in the 6000-2000 µm fraction in both stream sediments and soils. The elements associated with the mineralization are concentrated in the coarse fraction because the mineralized silica resists grain size reduction during soil development.

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SAMPLE MEDIA – SUMMARY TABLE

Sample Medium	Indicator Elements	Analytical Methods	Detection Limits (ppm)	Background (ppm)	Threshold (ppm)	Max anomaly (ppm)	Dispersion distance (m)
-200 µm Stream sediments	Au	GFAA*	0.001	0.001	0.008	0.160	1000x800
	As	Nit/Per	5	10	20	215	1000x800
	Sb	Nit/Per	1	1	3	32	1000x800
-200 µm Soils	Au	GFAA*	0.001	0.001	0.008	1.400	1200x1500
	Au	GFAA*	0.001	0.001	0.250	1.400	1000x300
	As	Nit/Per	5	10	20	390	1000x800
	As	Nit/Per	5	10	80	390	250x350
	Hg	HCl-CV	0.005	0.010	0.040	2.020	1000x300
	Tl	Nit/Per	0.020	0.400	0.800	15	1500x400

* After aqua regia digestion