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Mineralogy of heavy concentrates, Jane River Goldfield

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Abstract

Concentrates from the Jane River goldfield contain major amounts of quartz, chromite and rutile, with minor zircon, gold and 'leucoxene' and trace tourmaline, pyrite and limonite. Gold grains are up to about 15 mm in size, usually very irregular in shape, and some are crystallised aggregates or show overgrowths, suggesting very little transport and probable growth *in situ.* Much of the chromite is also relatively fresh and euhedral, and a nickel-rich sulphide inclusion in gold was detected, suggesting proximal ultramafic bodies as a source of some of the sediment and mineralisation. The high mercury content of the gold is unusual, and suggests an epithermal origin for the gold.

INTRODUCTION

Five samples of heavy concentrates were submitted for identification by members of the syndicate prospecting the Jane River (Warnes Lookout) goldfield (Table 1).

This prospect has been described by Finucane and Blake (1933), Blake (1936), Solomon (1968), and Jennings (1974). The major workings are concentrated around Reward Creek (418 300 mE, 5 304 700 mN). The source of the gold, which occurs in Cainozoic gravels, is not known but has been suggested to be local quartz veins (Finucane and Blake, 1933) or limonitic beds (Blake, 1936). Jennings (1974) considered that the deposit may represent secondary (reprecipitated) gold.

Table 1. *Sample Details*

Registered No.	*Description*
C102665	1. Pit 10, top 75 cm, 1st pan
C102666	2. Bank behind Pit 10, ~0.3 m^3
C102667	3. Tims Find, 10 m W G Hut
C102668	4. Tims Find, 2nd run, 3 full drums
C102669	5. W. side ground near road crossing, 10 buckets.

All samples consist of approximately 50 g of medium sand-sized material.

RESULTS

The samples were examined by reflected, transmitted, and stereo microscopy; the mineral constitution of the samples is summarised in Table 2 and the minerals are described below.

Quartz is predominantly present as angular grains of medium-grained to very fine-grained quartzite or metamorphosed vein quartz. This grades into lithic particles where a little fine-grained mica is present. Some typical vein quartz is present, and this is commonly more rounded, suggesting reworking or greater transport.

Chromite appears as relatively well crystallised, slightly rounded octahedra under the stereo microscope but is usually ragged or somewhat irregular in thin section, and some triangular pits were noted. This etching indicates post-depositional leaching. Grains are often crazed and partly oxidised to 'ferritchromite'-like minerals (probably predepositional) (Haggerty, 1976; Wylie, Candela, and Burke, 1987). The colour in polished section varies considerably from brownish to greenish grey (fig. 1), indicating considerable compositional variation, but the red internal reflections on thin edges are almost ubiquitous. Probe analyses indicate a range in compositions which are generally chromium-rich (Table 3, fig. 5) and mostly very similar to chromites from the Layered Dunite-Harzburgite successions of western Tasmania (Brown *et al.*, 1988). Some less chromian spinels present (fig. 5) are similar to those of the Layered Pyroxenite-Dunite successions of western Tasmania (Brown *et al.*, 1988). Compositions overlap the fields of both chromite (*sensu stricto*) and magnesiochromite.

Rutile grains are angular to slightly rounded and usually appear to be parallel aggregates of crystals with slightly ragged ends. The colour is usually reddish to yellowish brown, and twinning is abundant.

Zircon is present mainly as subrounded prismatic crystals, sometimes well rounded, or angular where broken, with a pale pink colour.

'Leucoxene' (fine-grained aggregates of titanium oxides and other minerals) occurs as angular to subrounded yellow to brown grains.

Gold occurs as very irregular grains, often amoeboid, dendritic or platy in shape (figs. 2, 3), with a good deep-yellow colour indicating a low silver content. Gold is commonly up to 6 mm in major dimension in these samples, and grains up to about 15 mm have been seen. In section the grains are usually very porous and show little or no colour zoning. One grain, however, consisted of a rounded gold grain with a porous rim of secondary gold, obviously post-depositional (fig. 4). Under the stereo microscope, inclusions of quartz and chromite appear to be present but most of this material appears, in section, to be grains embedded during transport and deposition. There are, however, some probable primary inclusions, including quartz, pyrite and an unidentified Ni-Co-Fe-As

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sulphide (gersdorffite?). Electron microprobe analyses (Table 4, fig. 6) indicate variable but unusually high mercury (<14 wt.%) and unusually low silver (< 2.5 wt.%) contents. Many grains show compositional zoning, with a decrease in mercury and silver towards the rims of grains (see Table 4). The low analytical totals, particularly near the rims, reflect the porosity of these grains.

Other minerals include tourmaline (prismatic, brown); limonite (very fine aggregates); pyrite (etched, subrounded to angular grains); iron (rusty flakes, contamination?); magnetite spheres (meteoritic?); corundum? (colourless, subrounded); spinel? (pale brown, rounded); and cinnabar? (angular, carmine).

DISCUSSION

The mineralogy of these concentrates indicates that the sediments are fairly immature, with an abundance of relatively angular grains which cannot have travelled a great distance. This applies to the gold as much as the other minerals, and in fact the gold could well have precipitated *in situ*, as postulated for many other alluvial deposits (Boyle, 1979). Etching of chromite and pyrite indicates rather acidic groundwater, which may be carrying gold as humic acid complexes. Presumably there must still be a gold-enriched source rock which has not yet been identified, although some local limonitic beds and quartz veins have been considered prospective (Blake, 1936; Finucane and Blake, 1933).

The source of chromite is likely to be ultrabasic rocks of the type relatively common in western Tasmania, as the compositions are rather distinctive (Brown *et al.*, 1988). The relatively fresh nature of much of the chromite indicates the source may be local, but it may be glacially derived or be reworked from Lower Palaeozoic rocks present locally (N. J. Turner, pers. comm.).

The origin of the mercury in the gold and cinnabar is rather more difficult to explain. Mercury-rich nuggets and grains have been described in the Yukon placers by Boyle (1979), and in Proterozoic placers of the Witwatersrand basin by Reid *et al.* (1988), but mercurian gold seems otherwise rare (Antweiler and Campbell, 1977; Chisholm, 1979), and its significance in the above deposits is not understood. Mercury deposits are usually found to be epithermal or low temperature hydrothermal deposits, often associated with hot springs (Pennington, 1959; Brobst and Pratt, 1973) but it may be noteworthy that many mercury deposits in California and Turkey are associated with ultrabasic rocks (Barnes *et al.*, 1973; Yildiz and Bailey, 1978). Boyle (1979) has noted the occurrence of mercury in epithermal gold-bearing veins, mostly as solid solution in sphalerite and tetrahedrite but uncommonly as cinnabar and mercurian gold. Such veins are most common in the Tertiary, but are known in rocks as old as Precambrian greenstones of Rhodesia, and usually occur in belts of mercury-rich rocks, commonly volcanics (Boyle, 1979). He also notes that cinnabar and mercury are relatively stable to weathering, but are lost during prolonged oxidation. The possibility thus exists that the cinnabar and gold are detrital, derived from gold veins, or they may form *in situ*, as is likely for the gold. Either way, the origin of the mercury is enigmatic at present.

We are thus faced with difficulties in explaining the sources of three of the major economic components of these alluvial deposits: gold, mercury and chromite. Some basic geological and geophysical reconnaissance is recommended to determine the likely source rocks.

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Table 2. *Mineralogy of heavy concentrates from the Jane River goldfield (approx. %).*

Mineral	C102665	C102666	C102667	C102668	C1026695
Quartz/lithics	40	70	20	15	25
Tourmaline	tr	tr			tr
Zircon	10	5	10	tr	10
Rutile	20	10	15	15	20
Leucoxene	10	5	tr	tr	tr
Chromite	20	10	55	70	45
Limonite	tr	tr	tr	tr	tr
Pyrite			tr	tr	tr
Iron				tr	tr
Gold	tr	tr	tr	tr	tr
Other			?corundum	magnetite*	?spinel

tr: trace
Blank: not detected
*: meteoritic spherules

Table 3. *Electron microprobe analyses of chromite (sample C102668B)*

	B	L*	C1	C2c	C2r	C3	C3r	C/Lc	C/Lr	C4	C5	C6c	C6r
TiO_2	0.00	0.00	0.00	0.00	0.66	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00
Al_2O_3	1.36	3.20	14.46	5.74	0.67	4.99	2.94	5.21	3.97	5.28	1.69	3.97	3.54
Cr_2O_3	70.54	73.35	56.44	69.34	56.91	71.37	63.03	72.37	70.53	60.82	73.38	71.31	71.00
FeO	11.86	12.64	21.04	24.36	18.04	18.38	15.47	16.35	13.93	27.25	14.98	16.52	16.78
MnO	0.00	2.93	0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MgO	10.28	8.26	9.73	4.45	0.70	11.21	7.43	14.21	13.75	7.14	9.65	10.23	3.90
Sum	94.04	100.38	101.67	103.89	77.66	105.95	89.09	108.14	102.18	100.49	99.70	102.03	95.22
No. of ions on the basis of 8(O)													
Ti	0.000	0.000	0.000	0.000	0.024	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000
Fe	0.360	0.364	0.563	0.690	0.719	0.489	0.500	0.418	0.378	0.779	0.432	0.460	0.525
Al	0.058	0.130	0.545	0.229	0.038	0.187	0.134	0.188	0.152	0.213	0.069	0.156	0.156
Cr	2.025	1.997	1.428	1.856	2.143	1.793	1.927	1.748	1.807	1.644	2.002	1.877	2.101
Mn	0.000	0.085	0.000	0.000	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mg	0.556	0.424	0.464	0.225	0.050	0.531	0.428	0.647	0.664	0.364	0.496	0.508	0.218

*Sample contains a few % zinc, not determined quantitatively.
Lower case c and r in the Sample Number indicate core and rim analyses respectively.

Table 4. *Electron microprobe analyses of gold from the Jane River goldfield, sample 102668b.*

	Wt. %				At. %		
Grain No.	Au	Ag	Hg	Total	Au	Ag	Hg
A1	82.46	0.28	5.85	88.59	92.95	0.58	6.48
C1c	83.45	1.21	2.86	87.52	94.33	2.50	3.17
C1r	70.92	0.50	1.19	72.61	97.15	1.25	1.60
D1	88.10	1.02	14.12	103.24	84.85	1.79	13.35
D1r	71.35	0.53	7.88	79.76	89.13	1.21	9.67
D1r2	82.00	1.17	3.28	86.45	93.87	2.45	3.69
D1 neck	64.26	0.22	0.91	65.39	98.02	0.61	1.36
B1c	81.33	2.52	4.18	88.03	90.33	5.11	4.56
B1r	82.85	1.52	1.68	86.05	94.93	3.18	1.89
B1c2	80.19	2.12	4.90	87.21	90.23	4.36	5.41
B1r2	81.89	1.81	0.99	84.69	95.04	3.84	1.13
E1	74.73	2.53	13.62	90.88	80.59	4.98	14.42
G1c	88.25	2.33	1.01	91.59	94.39	4.55	1.06
H1c	83.82	2.48	6.78	93.08	88.23	4.77	7.01

Lower case c and r in the Sample Number indicate core and rim analyses respectively.

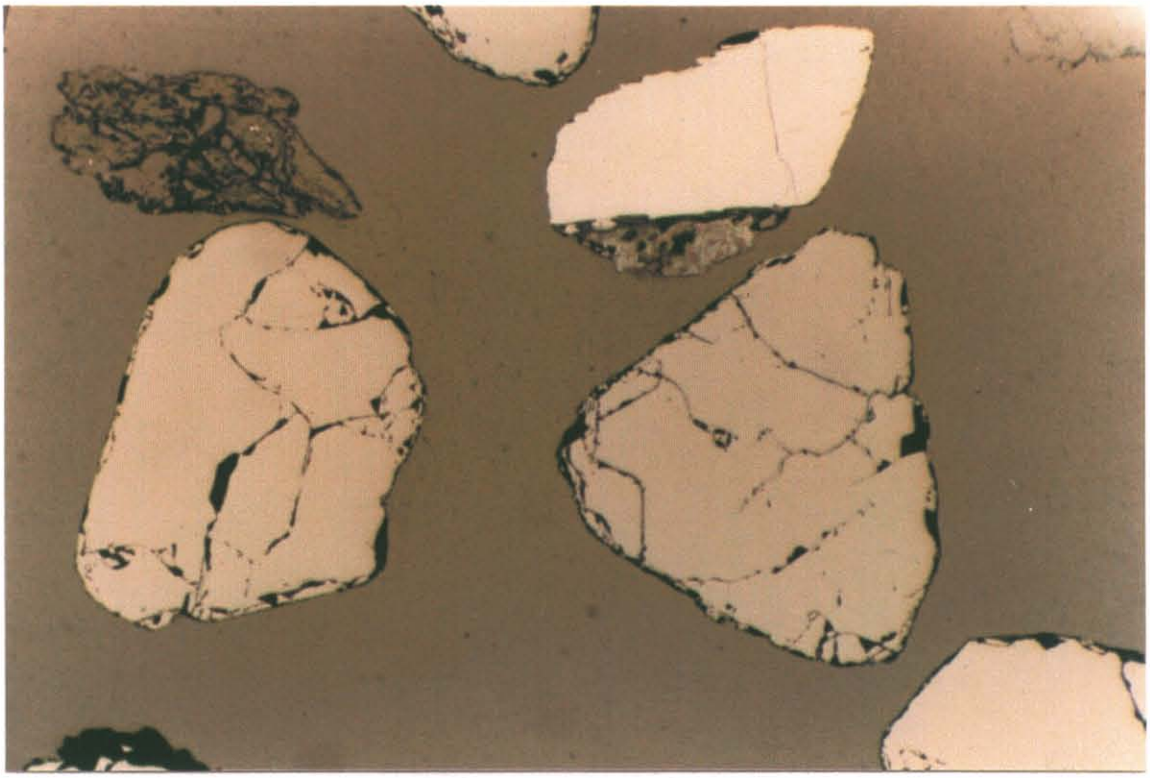

Figure 1. *Chromite crystals (pale brown), slightly etched and rounded, about 200 µm in diameter. Rutile (white) and quartz (grey) are also present.*

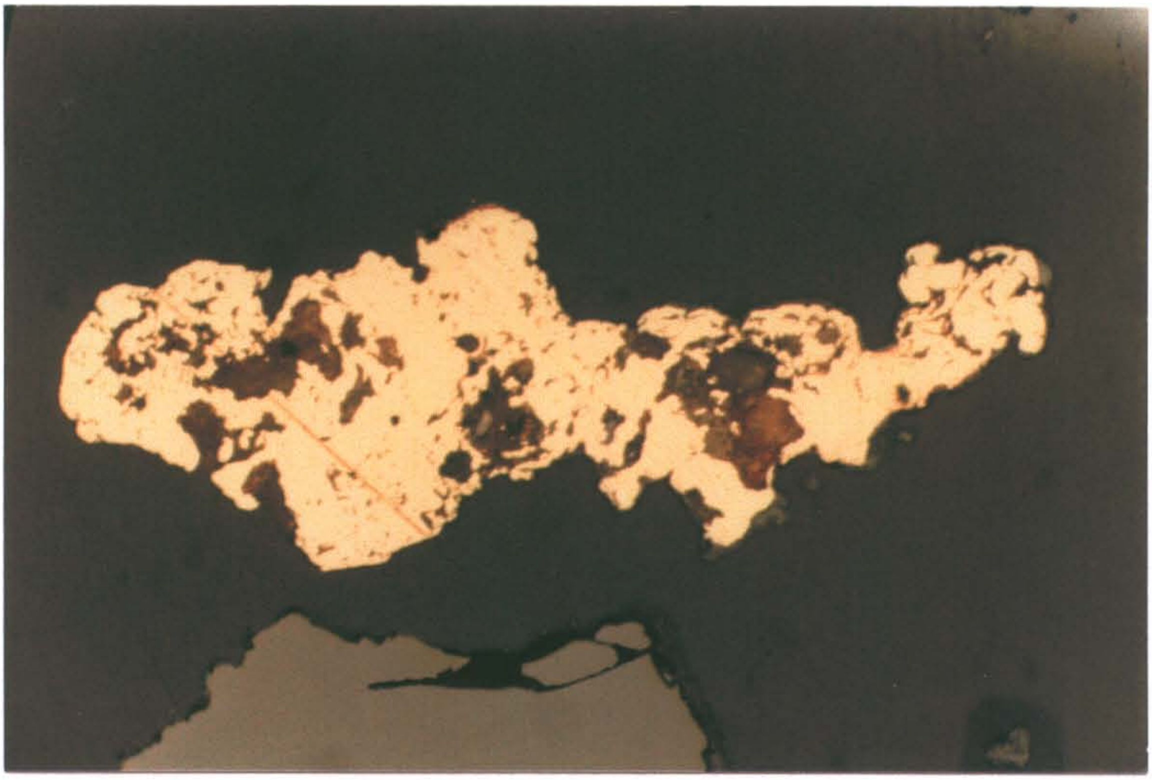

Figure 2. *Porous gold (yellow), about 400 µm long (many of the pores are submicron-sized, while the larger ones may contain some quartz and other inclusions). A grey-brown chromite is also present.*

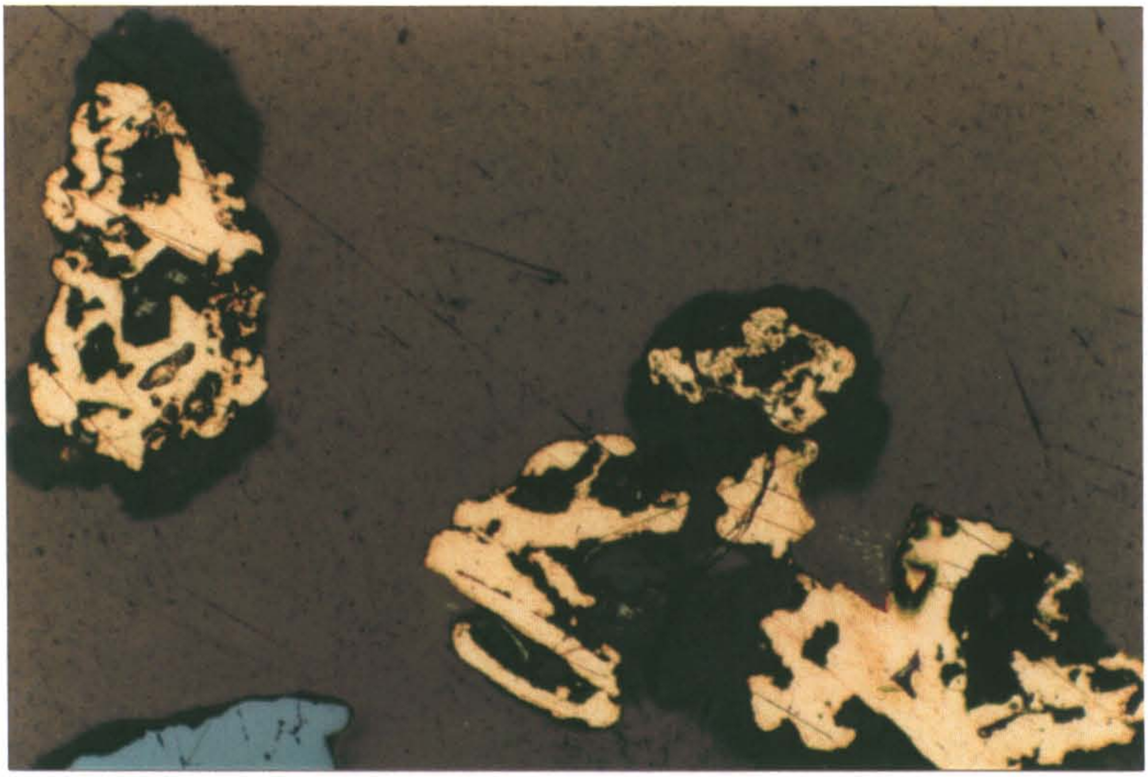

Figure 3. *Highly skeletal (?crystalline) gold grains. The grey grain is rutile. The field of view is about 1.1×0.7 mm.*

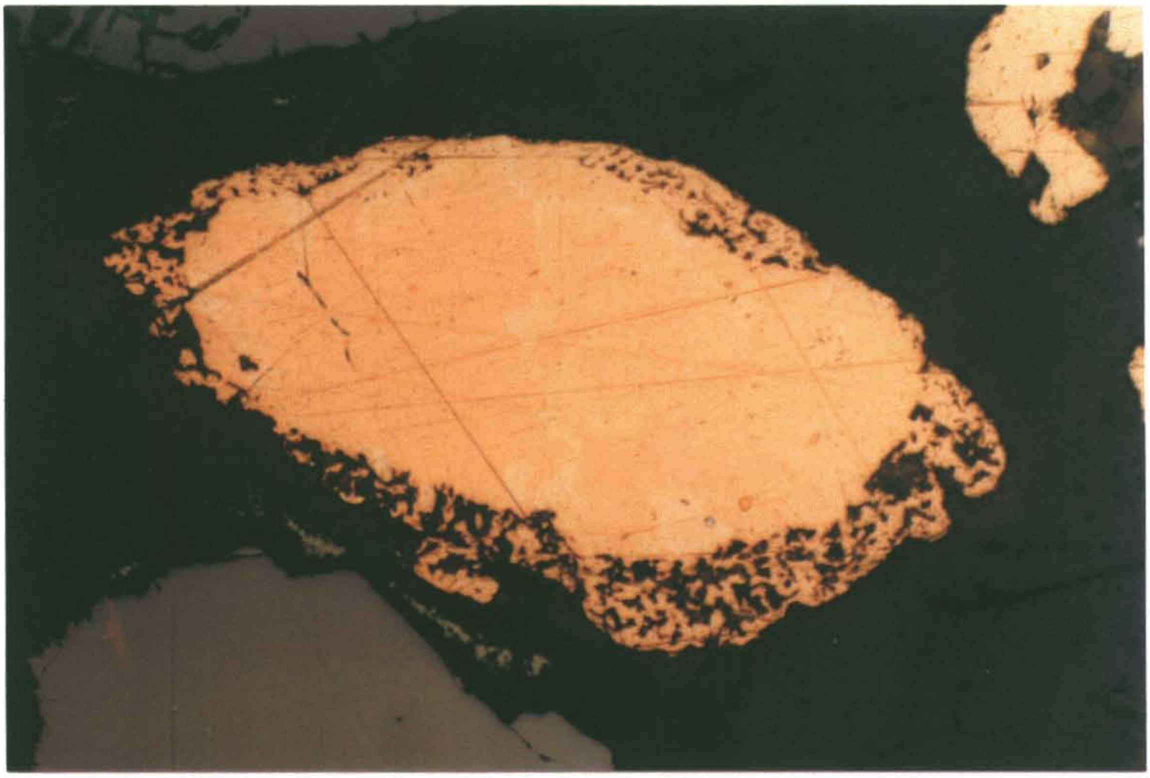

Figure 4. *A rounded grain of gold with an overgrowth of very porous, secondary gold; about 300 µm in total diameter. A little irregular colour zoning can be seen in the gold core, probably indicating compositional variations.*

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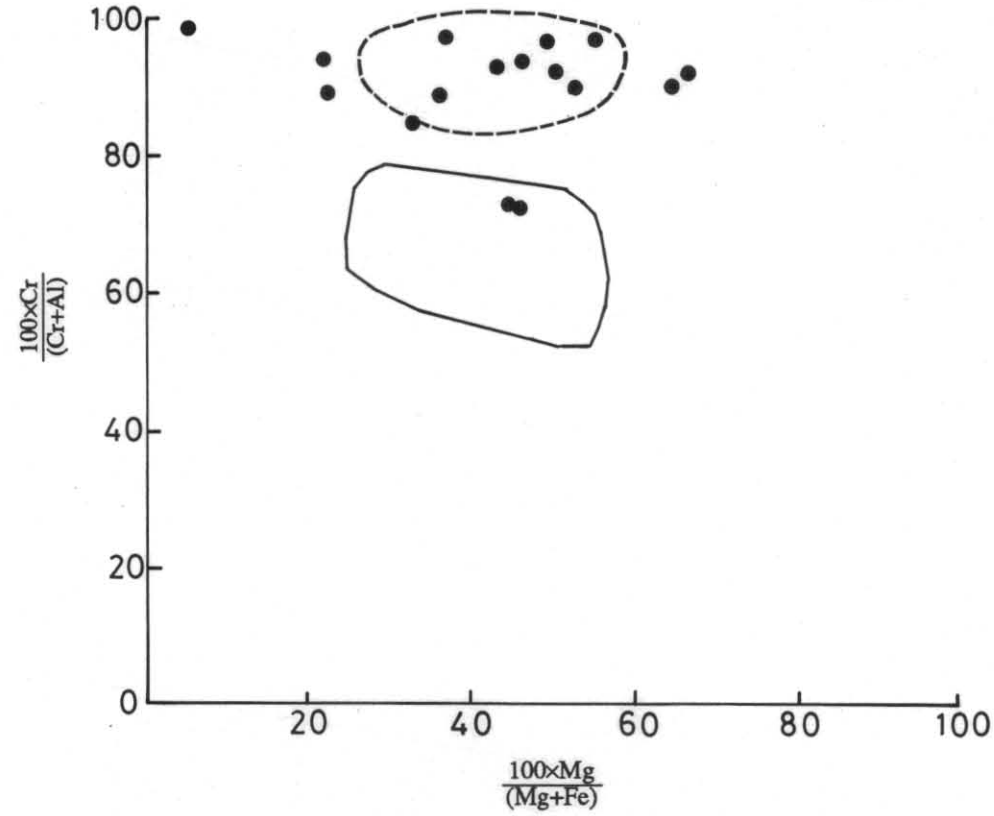

Figure 5. *Plot of compositions of chromite from the Jane River goldfield, showing the fields for chromite in Tasmanian ultramafic sequences (from Brown et al., 1988). Solid line: chromite from layered pyroxenite-dunite successions; Dotted line: chromite from layered dunite-harzburgite successions.*

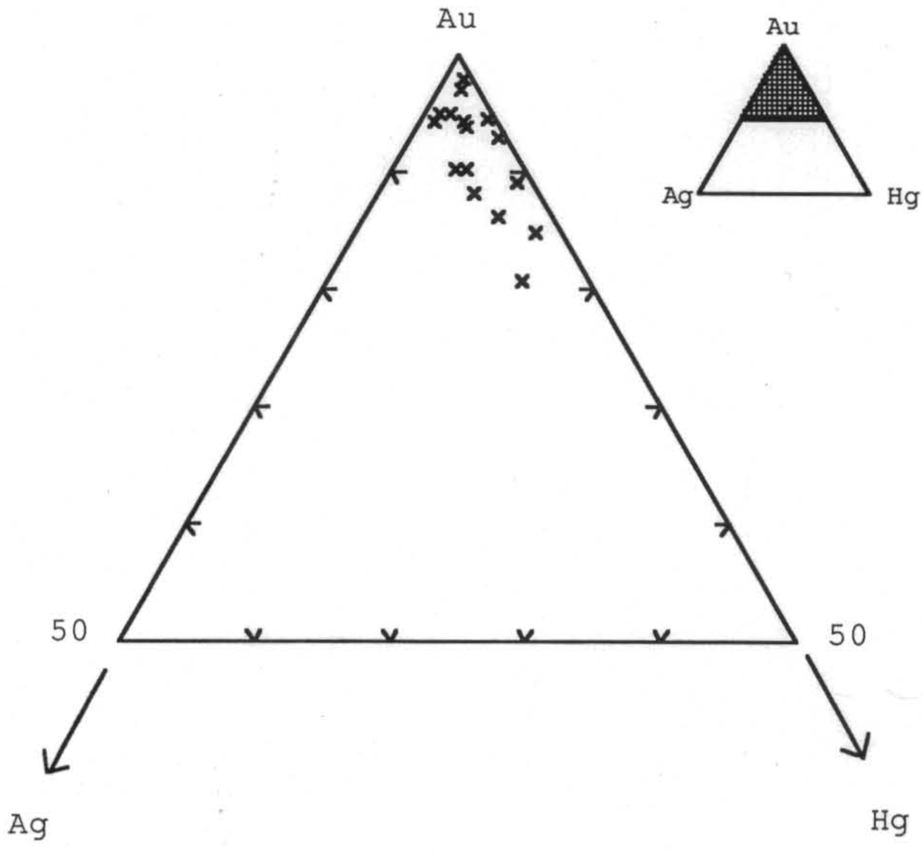

Figure 6. *Composition of gold from the Jane River goldfield (atomic %).*