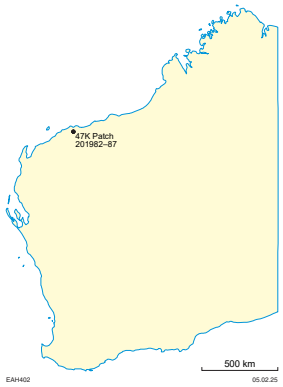
201987: gold grain, 47K Patch prospect (Sholl Terrane, northwest Pilbara Craton)

Sample type	Gold grain
Total weight	0.8 g
Sample location	47K Patch, about 32 km south of Karratha
Coordinates	MGA Zone 50, 492217E 7676570N
Datum	GDA94
1:250 000 map sheet	Yarraloola (SF 50-6)
1:100 000 map sheet	Pinderi Hills (2255)
Tenement	E 47/3443; P 47/2039-S
Collector	Artemis Resources Limited



Location and sampling

The sample was provided by Artemis Resources Limited in January 2019. It was collected from a colluvial/eluvial scree (compiled out of the GSWA 1: 100 000 scale geological series map; GSWA, 2020), at the 47K Patch prospect in the northwest Pilbara region (Artemis Resources Limited, 2019, written comm., 11 January).

Geological context

The 47K Patch prospect is located about 6 km east of the Maitland Shear Zone interpreted as a low angle thrust, in the Sholl greenstone belt of the Sholl Terrane, in the northwest Pilbara Craton (Hickman, 2016; GSWA, 2020). The local bedrock includes metamorphosed pillow and massive basalt, dolerite sills, and minor felsic tuff, sandstone, shale, and chert of the 3117 – 3115 Ma Bradley Basalt. Metamorphosed massive hornblende monzogranite and syenogranite of the c. 2930 Ma Yannery Granite are exposed about 0.7 km east-southeast of the sample locality. Northeasterly striking Proterozoic dolerite dykes transect the area (Hickman, 2021, 2022; GSWA, 2020).

Artemis Resources Limited recovered around 6 kg (193 oz) of nuggety and fine-grained gold from colluvial–eluvial scree the 47K Patch prospect in 2018, during shallow surface rehabilitation work. The gold is believed to have been shed from bedrock conglomerate-hosted mineralization (Artemis Resources Limited, 2018).

The nearest regolith landform — mapped by GSWA at the 1: 100 000 scale — is an alluvial–fluvial unit comprising unconsolidated gravel, sand, silt, and clay in active, but poorly defined drainage channels on floodplains (GSWA, 2020).

Methodology

The gold sample was photographed and weighed, and its overall morphology and external features, such as colour, roundness, surface relief, coatings, mineral inclusions, and mineral assemblages were recorded using visual morphometry. The raw surface of the sample was analysed using scanning electron microscopy with energy dispersive X-ray system (SEM-EDS). The sample was then mounted in epoxy resin, cut and polished, and the gold grain microstructure, inclusions, and silver content were examined using reflected-light microscopy and SEM-EDS. Gold microchemistry was determined by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), calibrated against certified gold reference materials (CRM; Murray, 2009). The sample was ablated in triplicate along 0.5 mm-long traverses and average values calculated for elements present in the CRM. The gold surface was repolished after laser ablation, etched with aqua regia, and internal structure examined using reflected-light microscopy. Details of this method are described in Hancock and Beardsmore (2020).

Morphology

The gold nugget has dimensions of 8 x 7 x 2 mm, and a perfectly rounded, flattened (‘melon seed’) shape, with a smooth, shiny, brown surface, about 90% of which is covered by Fe oxide minerals (possibly maghemite) (Fig. 1).

SEM-EDS analysis of raw surfaces

Gold exposed at the surface of the nugget is compacted and has many scratches and pits (Fig. 2a). The microsurface of gold is porous, likely a dissolution texture (Fig. 2b). There is no detectable Ag in the nugget surface.

Figure 1. Sample 201987: gold grain, 47K Patch prospect

LA-ICP-MS analysis

Ag, Cu and Hg were consistently detected within the gold grains, in concentrations higher than the instrument detection limit, and probably occur as limited solid solutions in the gold. The gold nugget contains 5.4–8.2% Ag, and moderate amounts of Cu (372–376 ppm) and Hg (266–448 ppm) (Table 1). High abundances of lithophile elements such as Na, Mg, Al, Si, Ca and additionally Ag and Hg, were consistently detected in two laser ablation traverses, suggesting the presence of rock-forming mineral micro- and nanophases, indicating a complex history of gold formation and alteration.

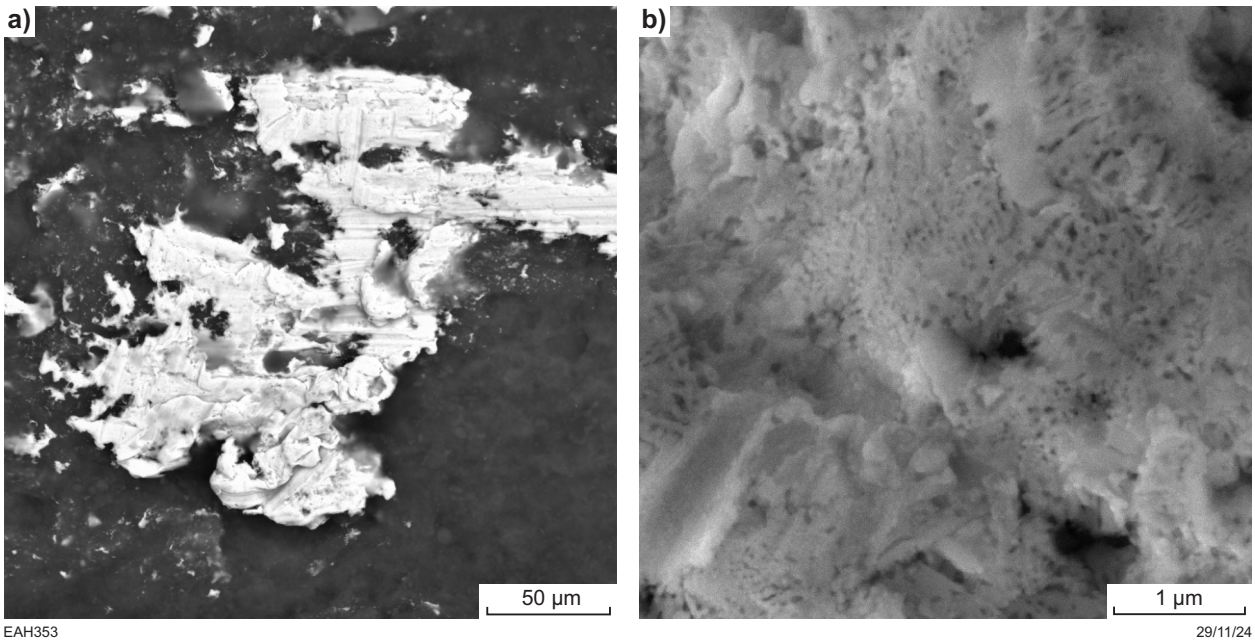


Figure 2. Reflected-light photomicrograph of part of polished surface of sample 201987: gold grain, 47K Patch prospect.

Optical microscopy of polished surfaces

In the polished section, the nugget is seen to consist of about 40% coherent gold and 60% Fe-oxide minerals (possibly maghemite). The boundaries between gold and Fe-oxide are ragged, and narrow intergranular veinlets cutting the gold are filled with Fe-oxides (Fig. 3).

SEM-EDS analysis of polished surfaces

Coherent gold contains 5% Ag. There is a small amount of pure (Ag-free) gold as nanoparticles in Fe-oxide minerals.

Acid etching

The microstructure of the gold is polycrystalline, with grains of variable size showing curved grain boundaries, and simple and polysynthetic uncoherent twinning (Fig. 4a–c) — features typical of deformation and recrystallization. The margins of gold grains in contact with Fe minerals are irregular to embayed (Fig. 4a,b), and sporadic intergranular veinlets are filled with Fe-oxides or Ag-free gold (Fig. 4c), all indicating gold dissolution. Gold exposed at the nugget surface has a rim up to 50 µm thick that is Ag-depleted but does not appear to be further recrystallized (Fig. 4d).

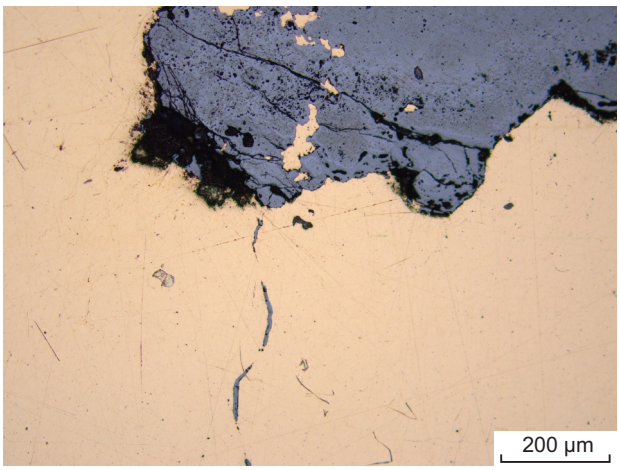


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Figure 3. Backscattered electron images of polished surfaces of selected areas of sample 201987: gold grain, 47K Patch prospect

Interpretation

The coherent gold in the nugget is polycrystalline and contains 5–8% Ag and moderate amounts of Cu and Hg, suggesting primary crystallization from hydrothermal fluids. However, the polycrystalline structure of the gold, and presence of more than 50% Fe-oxides throughout the nugget indicates subsequent extensive deformation, disaggregation and (possibly diagenetic or supergene) dissolution of the gold along intergranular veinlets to create voids that entrapped the Fe-oxide minerals. The external rim and new intergranular veinlets containing pure gold are the result of leaching of Ag from the gold during further alteration of the nugget in regolith.

Table 1. LA-ICP-MS data for main elements (above detection limit) in three traverses for sample GSWA 201987: gold grain, 47K Patch prospect

Ag (%)	*Cu (ppm)*	*Hg (ppm)*	*Other elements (ppm)*[1][2]
5.4	376	266	Al, Ca, Fe
7.0	372	448	Al, Ca
8.2	373	435	Mg, Al, Ca, Fe, Zn

NOTES: 1 See Table 2 for concentrations and detection limit
2 Results are only shown where standards are available for the element

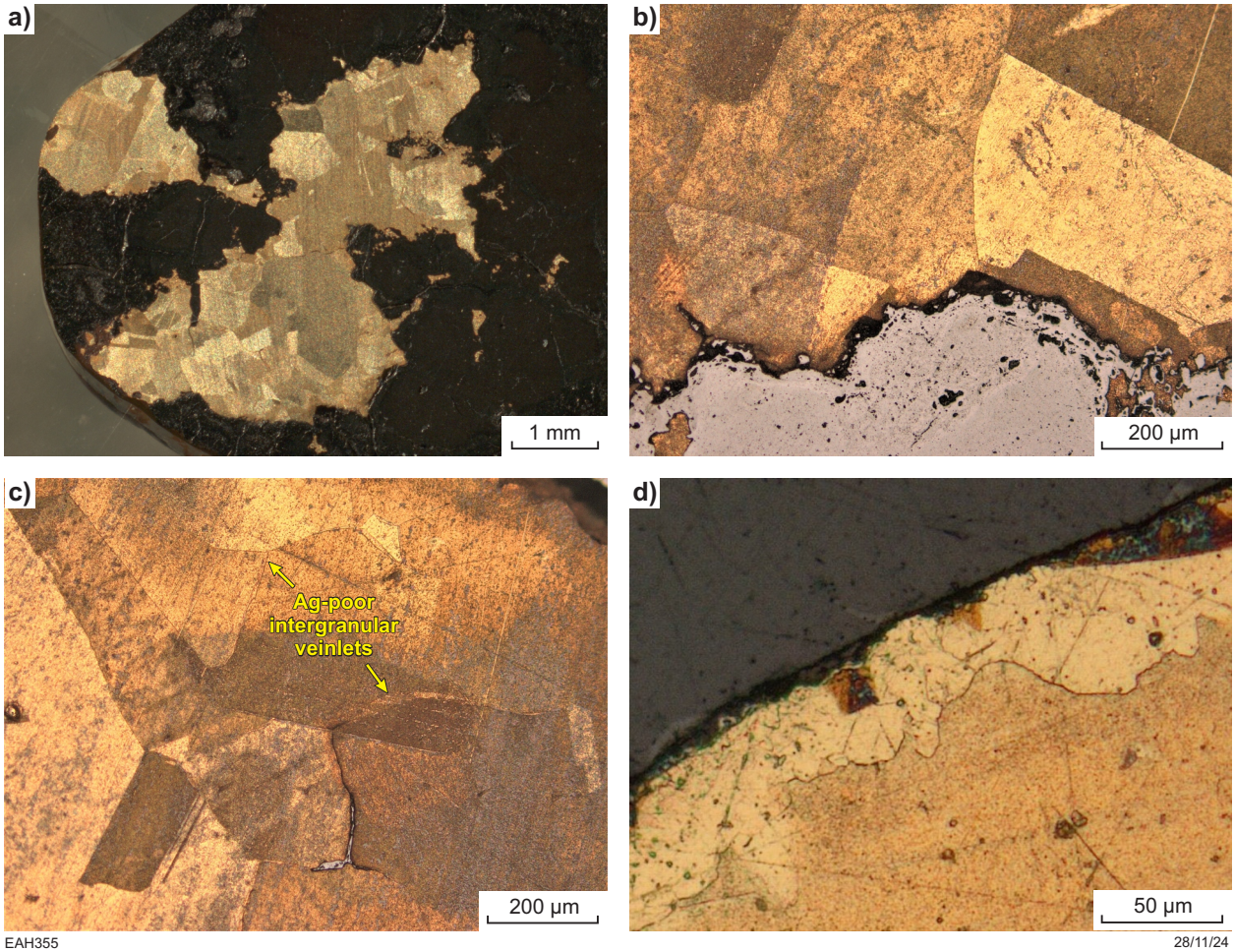

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Figure 4. Reflected-light photomicrographs, after repolishing and acid etching, of sample and parts of sample 201987: gold grain, 47K Patch prospect

Table 2. LA-ICP-MS compositional data for sample GSWA 201987: gold grain, 47K Patch prospect

Laser ablation track	*Unit*	*^{7}Li*	*^{9}Be*	*^{11}B*	*^{23}Na*	*^{25}Mg*	*^{27}Al*	*^{29}Si*	*^{44}Ca*	*^{45}Sc*	*^{49}Ti*	*^{51}V*	*^{53}Cr*	*^{55}Mn*	*^{57}Fe*	*^{59}Co*	*^{60}Ni*	*^{65}Cu*
1	cps			46		184	2090	64	40		35	21			106	1	23	26241
2	cps			70	70777	278	1115	133	55	1	29	2	13		13		24	25936
3	cps			227	155563	1543	4294		266		38	3	11	50	112	4	68	26028
1	ppm					1.8	2.82		5.29		0.58				4.34		0.34	376
2	ppm					2.7	1.50		7.20		0.48		0.21		0.56		0.35	372
3	ppm					15	5.79		34.5		0.63		0.19	0.14	4.58		0.97	373
*DL**	*ppm*					*3.3*	*1.3*		*2.6*		*1.5*		*1.7*	*1.1*	*3.4*		*2.9*	*1.5*

Laser ablation track	*Unit*	*^{66}Zn*	*^{69}Ga*	*^{72}Ge*	*^{75}As*	*^{82}Se*	*^{85}Rb*	*^{88}Sr*	*^{89}Y*	*^{90}Zr*	*^{93}Nb*	*^{98}Mo*	*^{101}Ru*	*^{103}Rh*	*^{108}Pd*	*^{109}Ag*	*^{111}Cd*	*^{115}In*
1	cps	186	7		16	2		8				3	1		94	6499427		
2	cps	88	3		19	6	9	17			11	1			95	8323637		2
3	cps	243	6			8	50	26		4	7			1	125	9764260		4
1	ppm	4.65			0.56	0.65									1.28	54400		
2	ppm	2.21			0.64	1.52									1.31	69700		
3	ppm	6.07				1.96									1.71	81800		0.02
*DL**	*ppm*	*5.3*			*2*	*3.1*								*1.5*	*1.8*	*2.4*		

Laser ablation track	*Unit*	*^{120}Sn*	*^{121}Sb*	*^{126}Te*	*^{133}Cs*	*^{138}Ba*	*^{139}La*	*^{140}Ce*	*^{141}Pr*	*^{145}Nd*	*^{151}Eu*	*^{157}Gd*	*^{159}Tb*	*^{162}Dy*	*^{165}Ho*	*^{167}Er*	*^{169}Tm*	*^{172}Yb*
1	cps	40	6	4	2	11	1											
2	cps	141	14		1	21												
3	cps	180	6			70	4	3										
1	ppm	0.29	0.05															
2	ppm	1.01	0.11															
3	ppm	1.29	0.05															
*DL**	*ppm*	*1.6*	*2.8*	*5.6*														

Laser ablation track	*Unit*	*^{175}Lu*	*^{178}Hf*	*^{181}Ta*	*^{182}W*	*^{185}Re*	*^{189}Os*	*^{193}Ir*	*^{195}Pt*	*^{202}Hg*	*^{205}Tl*	*^{208}Pb*	*^{209}Bi*	*^{232}Th*	*^{238}U*
1	cps				1					71711		4	4	1	
2	cps			1						121005		21	6		2
3	cps			2		2				117397	2	15	3		
1	ppm									266		0.04	0.03		
2	ppm									448		0.19	0.04		
3	ppm									435		0.14	0.02		
*DL**	*ppm*								*2.5*	*2.5*		*1.5*	*2.2*		

NOTES: cps, count per second; ppm, parts per million; DL, detection limit
*Detection limits have been determined using AuRM Reference Gold Standards (London Bullion Market Association). Standards were analysed nine times each and an average 2σ (95% Confidence Interval) Limit of Detection determined.Some results given in the text are quoted as values that are below the detection limit for these analytes. These values must be considered as “for information” only.

Acknowledgement

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Recommended reference for this publication

Hancock, EA, Blay, OA and Beardsmore, TJ 2025, 201987: gold grain, 47K Patch prospect; GSWA Mineralogy Record 21: Geological Survey of Western Australia, 5p.