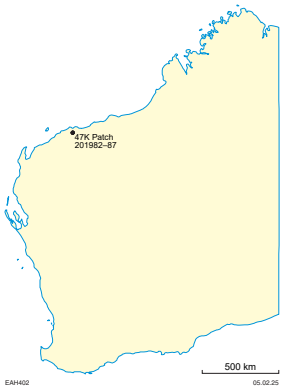
201985: gold nugget, 47K Patch prospect (Sholl Terrane, northwest Pilbara Craton)

Sample type	Gold nugget
Total weight	2.1 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. The gold nugget came from a colluvial/eluvial patch (compiled out of the GSWA 1: 100 000 scale geological series maps; 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 has recovered around 6 kg (193 oz) of nuggety and fine-grained gold from colluvial–eluvial scree at 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 ferruginous gold nugget has dimensions of 10 x 10 x 2 mm, and a perfectly rounded and flattened (‘melon seed’) shape, with a smooth, shiny, orange-brown surface overgrown by Fe-oxide minerals (Fig. 1).

SEM-EDS analysis of raw surfaces

The overall orange-brown surface of the gold nugget arises from a fine film of Fe–Al clays, and darker brown patches consist of Fe-oxide minerals. There is no detectable Ag on the nugget surface.

Optical microscopy of polished surfaces

In polished section, the gold in the nugget has ragged (dissolution) margins where it is in contact with Fe-oxide minerals and other regolith materials. Original dissolution voids and cavities are now filled with platy Fe-oxide minerals, quartz, and Al–Si clays containing abundant disseminated gold nanoparticles (Fig. 2). There is no gold in the Fe-oxides.

Figure 1. Sample 201985: gold nugget, 47K Patch prospect

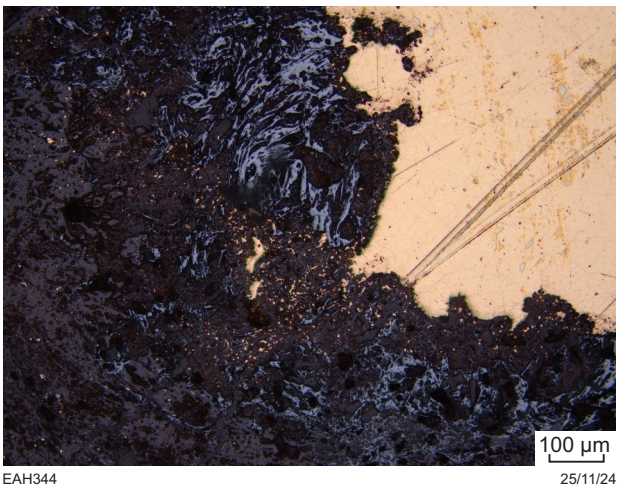


Figure 2. Reflected-light photomicrographs of polished surface of selected area of sample 201985: gold nugget, 47K Patch prospect

SEM-EDS analysis of polished surfaces

Coherent gold contains 6.3% Ag. Irregular solution voids in the gold are now filled with platy Fe-oxide minerals, clays, and gold micro- and nanoparticles. Very narrow intergranular veinlets are filled with clay or pure (Ag-free) gold (Fig. 3).

LA-ICP-MS analysis

Ag, Cu and Hg were consistently detected within the gold grain, in concentrations higher than the instrument detection limit, and probably occur as limited solid solutions in the gold. The gold contains 7% Ag, and high–moderate amounts of Cu and Hg (549–687 ppm and 325–411 ppm, respectively; Table 1). High abundances of lithophile elements, such as Na, Mg, Al, Si, and Ca detected in Traverse 2 probably indicate ablated rock-forming mineral inclusions (Table 2). The presence of other micro- and nano-inclusions in the gold nugget is also suggested from the consistent detection in other laser ablation traverses of measurable Mg, Al, and Ca and low (sub-ppm) concentrations of Ti, Cr, Fe, Ni, Zn, Sr, Pd, Ba, Os, and Pb.

Acid etching

The gold microstructure is polycrystalline and coarsely granular, with irregular-sized crystals and granulated grains with curved and angular boundaries and polysynthetic incoherent twinning, all indicting intense deformation and recrystallization (Fig. 4a,b). The nugget also has a locally preserved, 10–100 µm thick outer rim of finer-grained, granoblastic (recrystallized) pure gold (Fig. 4b,c), and intergranular veinlets, as part of the same alteration system (Fig. 4b).

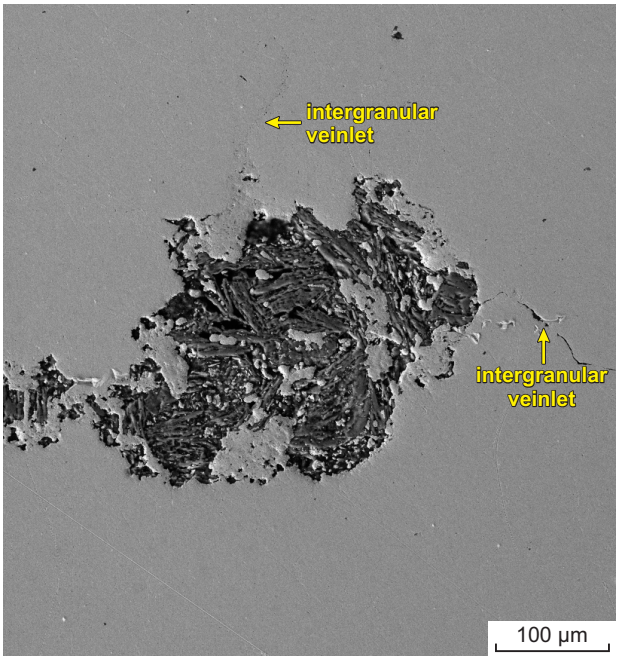


Figure 3. Backscattered electron (BSE) image of polished surfaces of selected area of sample 201985: gold nugget, 47K Patch prospect

Table 1. LA-ICP-MS data for main elements (above detection limit) in three traverses for sample GSWA 201985: gold nugget, 47K Patch prospect

Ag (%)	*Cu (ppm)*	*Hg (ppm)*	*Other elements (ppm[1])[2]*
6.7	687	325	Al, Ca
7.1	680	411	Mg, Al, Ca
6.9	549	336	Al, Ca

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

Table 2. LA-ICP-MS compositional data for sample GSWA 201985: gold nugget, 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			64		182	2113		122	4	6		2	4	2		96	47880
2	cps				14031	3259	13720	255	299	2	21		11	17	52	8	97	47387
3	cps			16		189	7333		66		15		2		21		3	38240
1	ppm					1.77	2.85		15.9		0.12		0.05	0.01	0.13		1.36	687
2	ppm					31.6	18.5		38.9		0.37		0.19	0.05	2.15		1.37	680
3	ppm					1.84	9.88		8.68		0.27		0.04		0.89		0.06	549
*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	59			6	6		15		1					11	7951560	11	
2	cps	110	4		30		5	14			2				13	8463899	5	
3	cps	11						6		2					12	8177171		
1	ppm	1.50			0.23	1.52									0.16	66600		
2	ppm	2.77			1.01										0.20	70900		
3	ppm	0.29													0.18	68500		
*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	117			1	5	3	3										
2	cps	171	3			9	4	5							2			
3	cps	73				5												
1	ppm	0.84																
2	ppm	1.23	0.03															
3	ppm	0.53																
*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						2			87806		10			
2	cps						1			110923		12			
3	cps			1			1			90746		5			
1	ppm									325		0.09			
2	ppm									411		0.11			
3	ppm									336		0.05			
*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.

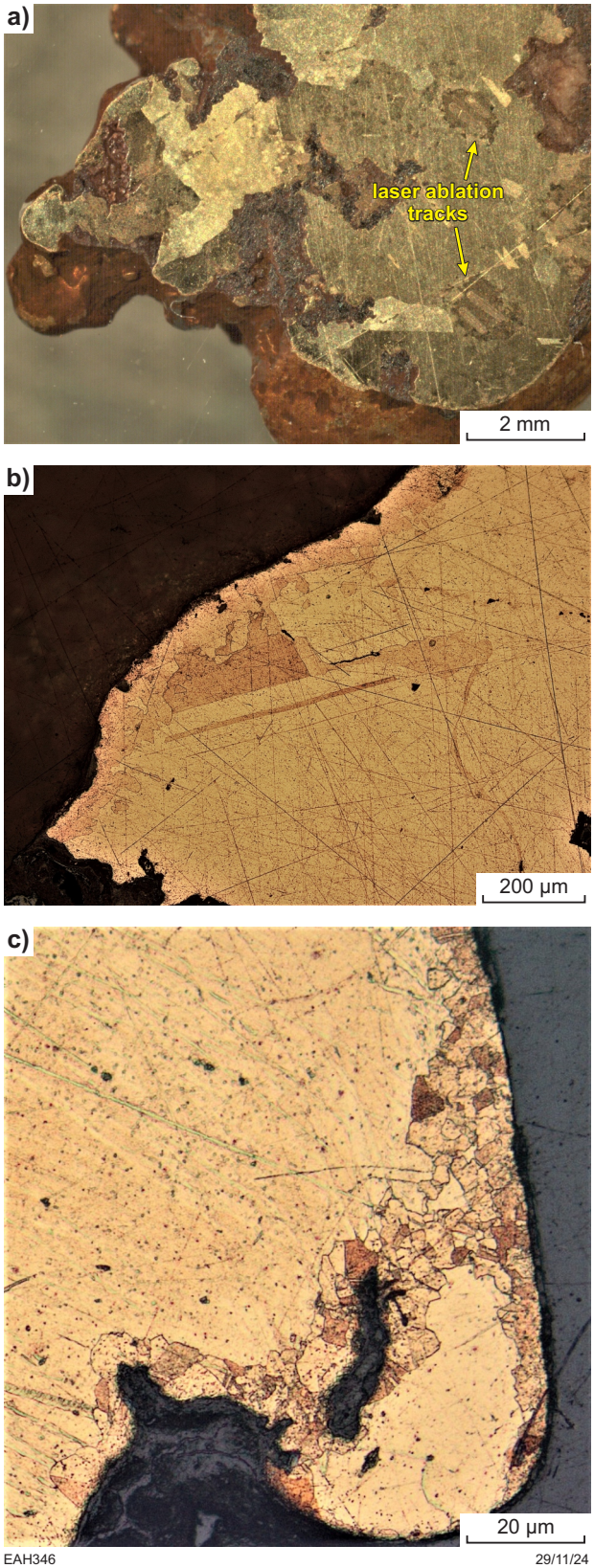


Figure 4. Reflected-light photomicrographs, after repolishing and acid etching, of parts of sample 201985: gold nugget, 47K Patch prospect

Interpretation

The coherent gold in the nugget is polycrystalline, contains 6–7% Ag and abundant Cu and moderate Hg, suggesting primary crystallization from hydrothermal fluids. Subsequent deformation and hydrothermal and diagenetic alterations removed Ag by dissolution along intergranular veinlets, recrystallized the gold and created deep voids that filled with ferruginous clay and gold nanoparticles. Subsequent erosion and transport of the nugget in the surficial environment recrystallized its outer rim and entrapped Fe-oxide minerals and Fe–Al-rich film on its surface.

Acknowledgements

The authors gratefully acknowledge Michael Verrall (CSIRO) for his help with the SEM-EDS operation and data interpretation. We thank Professor John Watling for discussions to improve the LA-ICP-MS data interpretation.

References

Artemis Resources Limited 2018, 225 Ounces of gold nuggets recovered from conglomerates (media release): Australian Securities Exchange (ASX), released 17 September 2018, 10p., <https://wcsecure.weblink.com.au/pdf/ARV/02022924.pdf>.

Geological Survey of Western Australia 2020, Northwest Pilbara, 2020: Geological Survey of Western Australia, Geological Information Series, data package (USB).

Hancock, EA and Beardsmore, TJ 2020, Provenance fingerprinting of gold from the Kurnalpi Goldfield. Geological Survey of Western Australia Report 212, 21p.

Hickman, AH 2016, Northwest Pilbara Craton: A record of 450 million years in the growth of Archean continental crust: Geological Survey of Western Australia, Report 160, 104p.

Hickman, AH 2021, Bradley Basalt (A-WHb-b): Geological Survey of Western Australia, WA Geology Online, Explanatory Notes extract, viewed 04 May 2023, <www.demirs.wa.gov.au/ens>.

Hickman, AH 2022, Yannery Granite (A-STya-gfh): Geological Survey of Western Australia, WA Geology Online, Explanatory Notes extract, viewed 04 May 2023, <www.demirs.wa.gov.au/ens>.

Murray, S 2009, LBMA certified reference materials. Gold project final update: The London Bullion Market Association, Alchemist, no. 55, p. 11–12.

Recommended reference for this publication

Hancock, EA, Blay, OA and Beardsmore, TJ 2025, 201985: gold nugget, 47K Patch prospect; GSWA Mineralogy Record 19: Geological Survey of Western Australia, 4p.