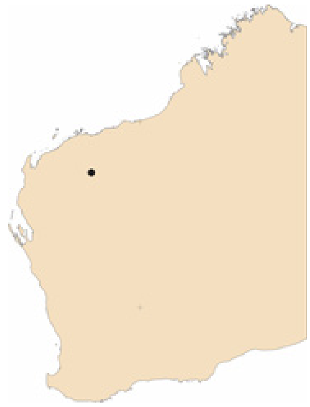
201968: gold nugget, Beasley Creek prospect

(Hardey Formation, South Pilbara Sub-basin)

Sample type	Gold nugget
Total weight	1 g
Sample location	Beasley Creek alluvial workings, about 41 km west of Tom Price
Coordinates	MGA zone 50, 541065E 7482992N
Datum	GDA94
1:250 000 map sheet	Mount Bruce (SF 50-11)
1:100 000 map sheet	Rocklea (2352)
Tenement	E 47/3490-I
Collector	Castle Minerals Limited



Location and sampling

The sample was provided by Castle Minerals Limited in October 2018. It was recovered from alluvial workings at the Beasley Creek prospect in the southern Pilbara (Castle Minerals Limited, 2018, written comm., 23 October).

Geological context

The prospect is located in the South Pilbara Sub-basin of the Fortescue Basin (Hickman et al., 2022). The alluvial workings at the Beasley Creek prospect overlie the informally named Mags Flow conglomerate unit of the Hardey Formation (Castle Minerals Limited, 2018, written comm., 23 October), and are located in the northern limb of the Rocklea Anticline (GSWA, 2018; Thorne et al., 1995).

The 2766–2749 Ma Hardey Formation of the lower Fortescue Group (sequence 2) includes a wide range of sedimentary, volcanic and intrusive rocks (Hickman et al., 2022). In this area, the Hardey Formation consists mainly of pelitic rocks and metasandstone, intruded by dolerite sills of the Boongal Formation (Howard, 2021). The Hardey Formation unconformably overlies Pilbara Craton granite–greenstone basement rocks along the northern margin of the Rocklea Inlier (Thorne and Tyler, 1996; Thorne et al., 1995) about 0.8 km to the south of the sample locality.

The nearest mapped regolith landform is a colluvium unit comprising unconsolidated quartz and rock fragments in soil (Thorne et al., 1995).

Methodology

The gold sample was photographed and weighed, its overall morphology and external features, such as colour, roundness, surface relief, coatings, mineral inclusions and mineralogical assemblages, were recorded using visual morphometry. The raw surface of the sample was analysed using scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS). The sample was then mounted in epoxy resin and polished to expose its microstructure and inclusions for examination 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 the internal structure examined using reflected light microscopy. Details of these methods are described in Hancock and Beardsmore (2020).

Morphology

The gold nugget is subrounded, with dimensions 12 × 6 × 2 mm, and has a spongy texture. Its surface is pitted and damaged, showing many imprints of now-absent matrix mineral grains. Cavities in the surface of the nugget are lined with pale clays (Fig. 1). Fe-oxide minerals are rare. The shiny appearance of the nugget suggests that it may have been cleaned with chemicals after it was collected.

SEM-EDS analysis of raw surfaces

The pitted surface of the nugget is partially filled with chlorite–illite with up to 7–12% Mg (Fig. 2a). Dissolution holes and scratches are observed on the gold microsurface (Fig. 2b).

Optical microscopy of polished surfaces

The polished surface of the gold nugget is pitted where inclusions of other minerals have been removed (Fig. 3a). Only very small (10–50 µm) inclusions of heterogeneous Ti-oxide minerals are present (Fig. 3b).

Figure 1. Sample 201968: gold nugget, Beasley Creek prospect

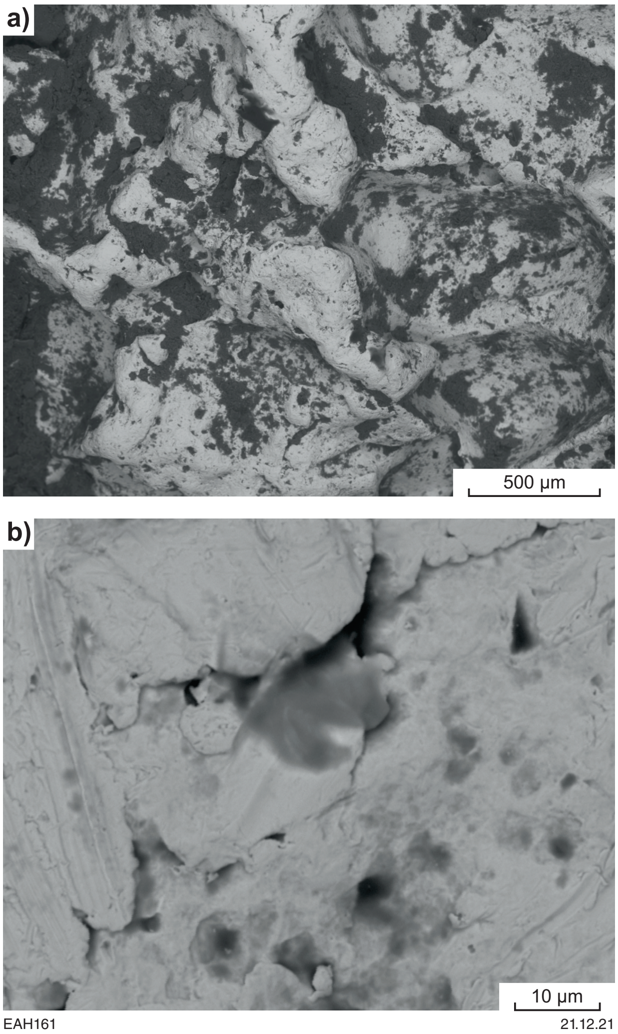


Figure 2. Backscattered electron (BSE) images of sample 201968: gold nugget, Beasley Creek prospect: a) pitted gold surface partially filled with chlorite–illite; b) gold microsurface showing scratches and dissolution holes

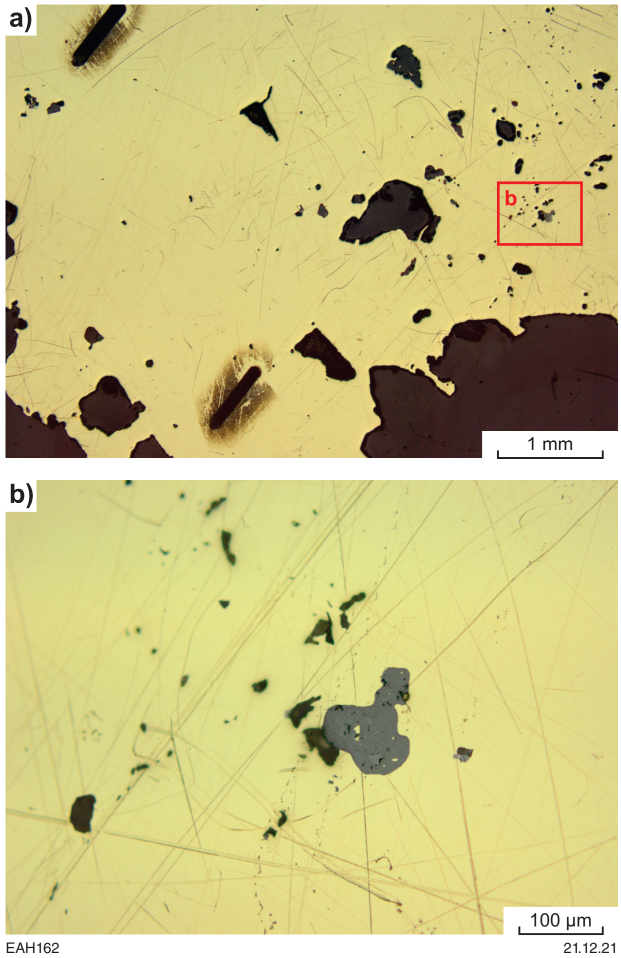


Figure 3. Reflected-light photomicrographs of polished surface of sample 201968: gold nugget, Beasley Creek prospect: a) pitted gold surface showing cavities from removed inclusions. Red square shows location of b); b) micro-inclusions of heterogeneous Ti-oxide minerals. Dark elongate lines are laser ablation tracks produced during LA-ICP-MS analyses

SEM-EDS analysis of polished surfaces

The bulk Ag content is 14–16%. Paler, thin veinlets on the margins of gold grains contain gold with no Ag (Fig. 4a). The surface also exhibits a rounded, irregular inclusion of ilmenite, about 100 µm in size, with associated quartz, and several µm-size inclusions of rutile and xenotime (Fig. 4b).

LA-ICP-MS analysis

Analyses consistently detected Ag, Cu and Hg within the gold grains, in concentrations higher than the instrument detection limit, probably occurring as limited solid solutions in the gold. Other trace elements were detected only sporadically in low (sub-ppm) concentrations, possibly occurring in micro- and nano-inclusions.

The nugget contains high Ag (13.5 – 14.0%), low Cu (79–106 ppm) and moderate Hg (543–621 ppm) (Table 1). In addition, low concentrations of Mg and Sb (<5 ppm; Table 2) were consistently detected in the sample.

Table 1. **LA-ICP-MS data for selected elements in sample 201968: gold nugget, Beasley Creek prospect**

Ag (%)	*Cu (ppm)*	*Hg (ppm)*	*Sb (ppm)*	*Mg (ppm)*
13.8, 13.5, 14.0	106, 79, 101	543, 621, 582	2.3, 1.6, 2.1	0.6, 1.8, 1.2

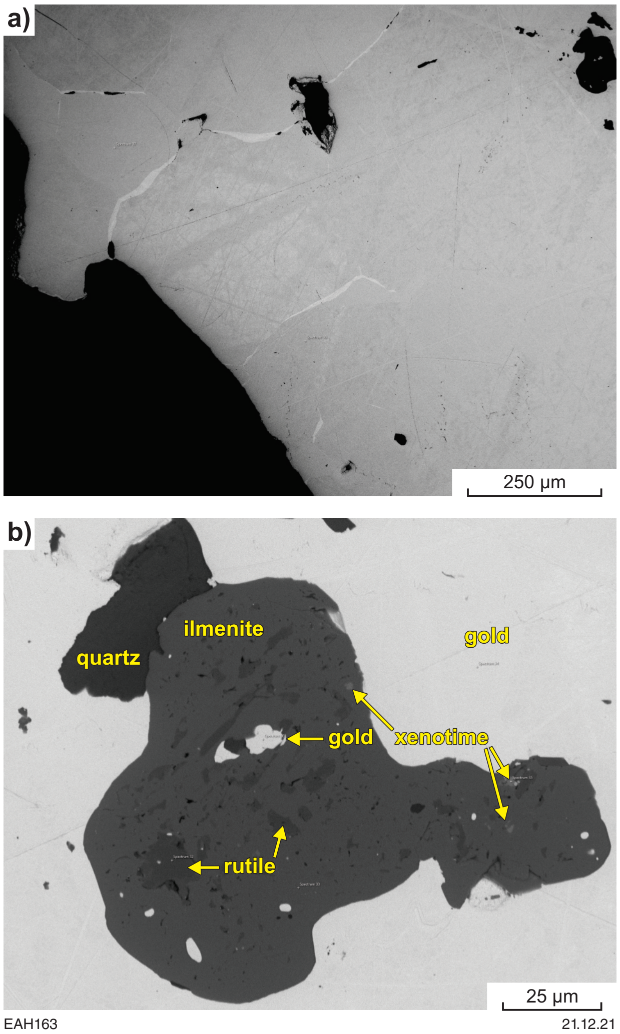


Figure 4. **BSE images of polished surface, showing: a) gold veinlets; b) mineral inclusions in sample 201968: gold nugget, Beasley Creek prospect**

Acid etching

Etching of the polished surface of the gold revealed a polycrystalline microstructure with coherent to incoherent, polysynthetic and simple twinning with flat to curviplanar boundaries (Fig. 5a,b), interpreted to indicate annealing (deformation and recrystallization) of the grain at elevated temperatures. Average crystal sizes decrease outwards from nugget centre to its margins (Fig. 5a). Very narrow intergranular veinlets of pure gold are observed in the deformed outer margin of the sample (Fig. 5c).

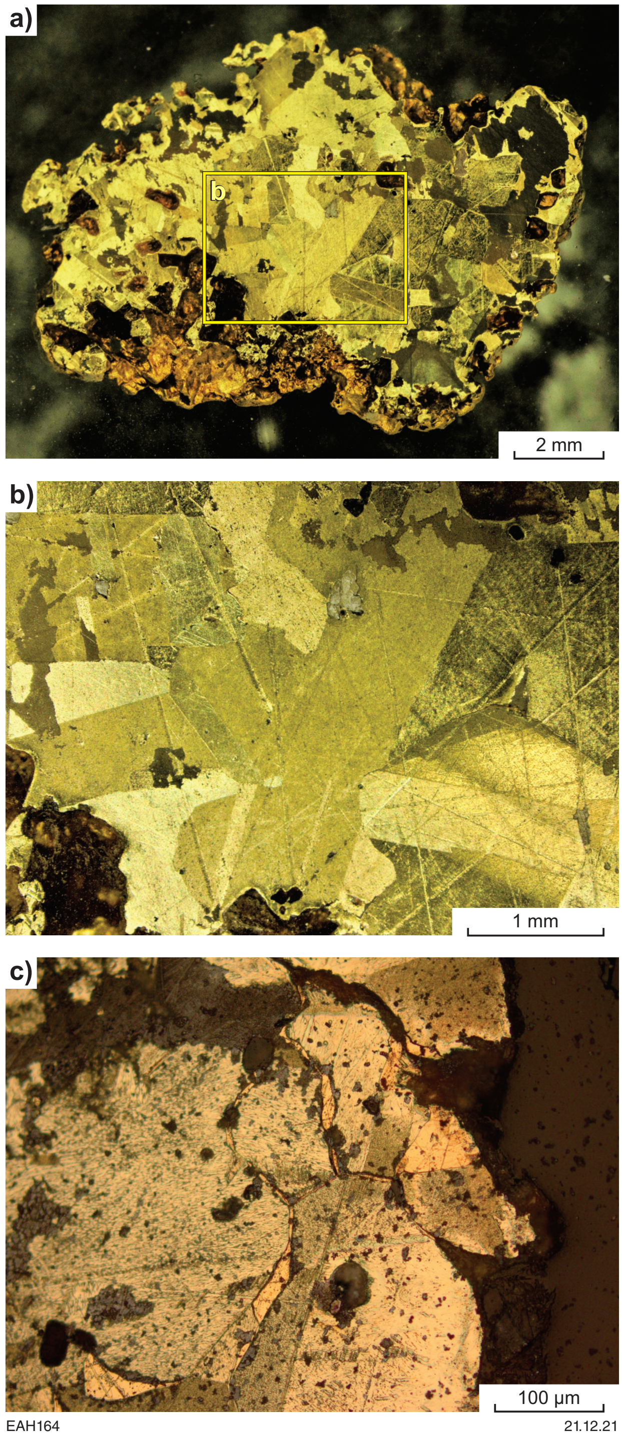


Figure 5. **a–c) Reflected-light photomicrographs, after repolishing and acid etching, showing the internal microstructure of sample 201968: gold nugget, Beasley Creek prospect. Yellow square shows location of b)**

Table 2. LA-ICP-MS compositional data for sample 201968: gold nugget, Beasley Creek 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					53	405			10	2	8	5		10		6	13172
2	cps		1			151	188				4	7	35	30	2	3	16	9760
3	cps		1			98	253		55		7		35	23			7	12448
1	ppm					0.63					0.04						0.06	106.40
2	ppm					1.81					0.09						0.16	78.84
3	ppm					1.17					0.15						0.07	100.55

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	15	1			3	2	12	1	1	2	1			8	28341958	4	
2	cps	21	3	2	1	9	3	13			17			2	5	27858312	6	
3	cps	26	2				2	13			6				6	28840197	5	1
1	ppm	0.17				0.20									0.06	137516		
2	ppm	0.24			0.01	0.72								0.004	0.03	135169		
3	ppm	0.30													0.04	139933		0.002

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	9	599	2		10												
2	cps	25	416	3		7		1	1									
3	cps	28	535		5	3												
1	ppm	0.04	2.33	0.04														
2	ppm	0.11	1.62	0.06														
3	ppm	0.12	2.08															

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*		*2*						*157432*		*11*	*16*		*2*
2	*cps*									*179990*	*2*	*13*	*26*		
3	*cps*					*1*	*1*			*168750*		*10*	*35*		
1	*ppm*									*543*		*0.03*	*0.034*		
2	*ppm*									*621*		*0.04*	*0.054*		
3	*ppm*									*582*		*0.03*	*0.073*		

Notes: cps, count per second; ppm, parts per million

Interpretation

The surface of the gold nugget has likely been treated after it was collected to produce a more shiny appearance. The nugget has a primary, polycrystalline internal texture with relatively high Ag concentration (14–16%), and contains minor, dispersed inclusions of ilmenite, quartz, rutile and xenotime. Narrow veinlets of pure gold occur at the outer margins of gold grains. The sample has undergone some burial alteration following transport over a relatively short distance to its discovery site.

References

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Recommended reference for this publication

Hancock, EA, Blay, OA and Beardsmore, TJ 2022, 201968: gold nugget, Beasley Creek prospect; GSWA Mineralogy Record 2: Geological Survey of Western Australia, 5p.