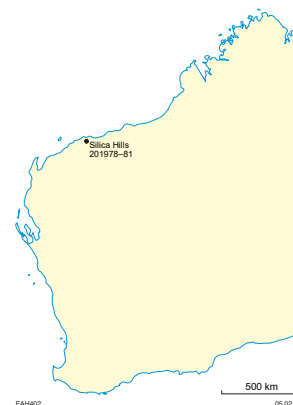


201978: gold grain, Silica Hills prospect

(Tozer Formation, Sholl Terrane)

Sample type	Gold grain
Total weight	0.4 g
Sample location	Silica Hills, about 25 km south of Karratha
Coordinates	MGA zone 50, 492458E 7684227N
Datum	GDA94
1:250 000 map sheet	DAMPIER (SF 50-2)
1:100 000 map sheet	DAMPIER (2256)
Tenement	M 47/232
Collector	Artemis Resources Limited



Location and sampling

The sample was provided by Artemis Resources Limited in January 2019. It was collected from the weathering profile above quartz-veined felsic volcanic rocks at the Silica Hills prospect, in the northwest Pilbara region (Artemis Resources Limited, 2019, written comm=, 11 January).

Geological context

The Silica Hills prospect is located about 4 km south of the Sholl Shear Zone, a significant terrane boundary in the Sholl greenstone belt of the Sholl Terrane, northwest Pilbara Craton (Hickman, 2016; GSWA, 2020). The local bedrock comprises metamorphosed rhyolite and dacite of the 3128–3116 Ma Tozer Formation, and basalt and basaltic andesite unit of the Tozer Formation that outcrops immediately north of the sample locality. Proterozoic dolerite dykes transect the area (GSWA, 2020; Hickman, 2021).

Gold mineralization in the area is typically residual to eluvial and alluvial (e.g. Sholl Northeast 2 Eluvial, Mt Sholl Dryblowing 1, Mt Sholl B1 East (Cu), Specimen, and Silica Hills). Eluvial gold and gold-in-soil geochemical anomalies appear to have been derived from small, shallowly dipping quartz veins along lithological contacts (Bob Clynch and Associates, 1988). High-grade gold mineralization discovered in 2017 by Artemis Resources Limited at Silica Hills consists of coarse nuggety gold with high silver content in a quartz vein stock work within a silicified intrusion along a shear zone (Artemis Resources Limited, 2017).

The nearest regolith landforms are a colluvial unit comprising unconsolidated sand, silt, and gravel in outwash fans, scree and talus, and proximal mass-wasting deposits, an alluvial–fluvial unit comprising unconsolidated sand, silt, and gravel 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 mineralogical 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 and inclusions 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 chromium trioxide in HCl solution, and its internal structure examined using reflected-light microscopy. Details of this method are described in Hancock and Beardsmore (2020). In addition, the gold surface was repolished after etching, and 500 x 300 microns surface area was mapped for distribution of selected trace elements using laser ablation spectrometry with sector field system (LA-SF-ICP-MS).

Morphology

The gold grain is lumpy, moderately rounded, and slightly flattened, with dimensions 6 × 3 × 2 mm. It is partly coated by ferruginous clays (Fig. 1).

SEM-EDS analysis of raw surfaces

The surface of gold grain is spongy to flaky and intensively scratched and pitted but shows no compaction (Fig. 2). There is no detectable Ag on the surface of the grain.

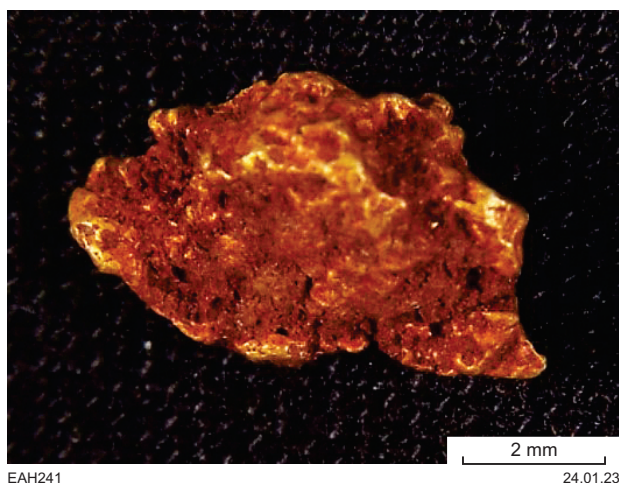


Figure 1. Sample 201978: gold grain, Silica Hills prospect

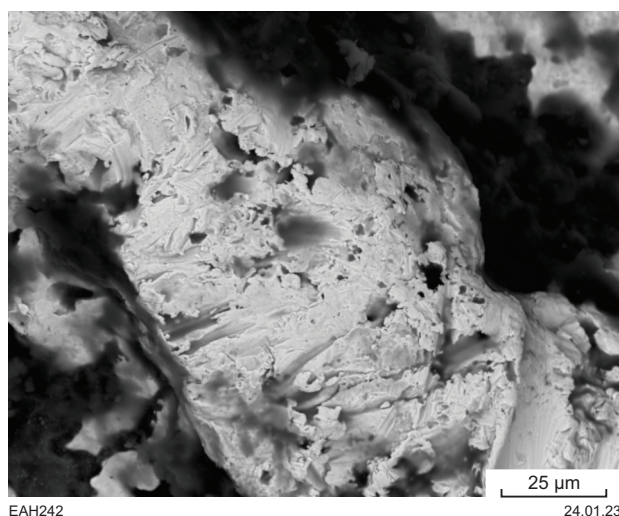


Figure 2. Backscattered electron image (BSE) of surface of sample 201978: gold grain, Silica Hills prospect

Optical microscopy of polished surfaces

The polished section reveals the slightly smoothed but irregular shape of the gold grain, and gangue mineral inclusions. The large cavities in the gold are filled with ferruginous clays and quartz grains (Fig. 3a), and there are a few small (<70 µm diameter), rounded to blocky galena inclusions, and rare narrow, dark yellow veinlets of Ag-free gold (Fig. 3a,b).

SEM-EDS analysis of polished surfaces

The bulk of the gold grain contains up to 23% Ag, but it is transected by narrow veinlets containing about 2% Ag, that outline the polycrystalline microstructure of the grain (Fig. 4a). Diffuse zones sporadically present adjacent to these veinlets, in which the Ag content in gold matrix is reduced to about 14% Ag. There are also a few small, rounded galena inclusions, and one hole imprinted with a blocky cleavage pattern from which a galena crystal may have been plucked during polishing (Fig. 4b). Gold nanoparticles are sporadically disseminated though regolith clays filling surficial voids and holes.

LA-ICP-MS analysis

Analyses consistently detected Ag, Cu and Hg within the gold grain, 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 gold grain contains very high Ag (17–19%), and low Cu (24–37 ppm) and Hg (74–79 ppm; Table 1). The maximum 23% Ag determined by SEM-EDS spot analysis is attributed to heterogeneous Ag distribution in the gold grain and averaging of Ag values calculated for laser ablation traverses. There are no other elements present in gold in concentrations above their detection limits (Table 2). A rock-forming small inclusion with elevated Al was detected in the laser ablation track 3.

Acid etching

Aqua regia was not used as an etching agent in this case because it would have reacted strongly with the abundant Ag in the gold to form an obscuring AgCl ‘passivation’ film. Etching was instead affected with a CrO₃-in-HCl solution, which produced red and green phases with diffused mutual contacts across much of the polished surface (Fig. 5a–c). This colour variation reflects zonation in Ag distribution, where the red phases mostly constitute a < 200 µm wide outer rim with depleted Au in contrast with the green phases. There are local twin planes revealed in the grain interior (Fig. 5a,b).

The Ag-poor intergranular veinlets and a thin (<30 µm), discontinuous surficial rim of Ag-poor gold remained bright yellow, and have sharp contacts with the recrystallized, Ag-depleted grain interior (Fig. 5b,c).

LA-SF-ICP-MS mapping analysis

The mapping of selected trace elements was run over a small area of the polished gold surface using LA-SF-ICP-MS (Fig. 6). Note, due to limit of gold standards, abundances of trace limits are shown in relative units. Trace elements are heterogeneously distributed in the gold. Most trace elements (As, Bi, Ce, Co, Ho, La, Mn, Ni, Pb, Y, and Zn) have low abundances, except along part of the outer rim, Ag-depleted gold margin, and particularly adjacent to, hydroxide minerals in a void (Fig. 6a–e, g–m). Mercury (note, cps values) is relatively enriched in the gold except adjacent to the grain margin (Fig. 6f). Bi, Ce, La and Pb are locally enriched in the top central part of the mapped area, suggesting the presence of a primary mineral micro-inclusion (perhaps galena; Fig. 6c,d,f,h,k).

Interpretation

This primary hydrothermal gold is coarsely granular, has high Ag and low Cu and Hg abundances, and small inclusions of galena. High Ag content and depletion of other trace elements are result of crystallization from low-temperature hydrothermal solutions carrying probably silver-chloride complexes. The nugget was subsequently released to the surface by uplift and erosion, then buried in the regolith, where Ag-depletion rim, the narrow, Ag-poor intergranular veinlets and surficial rims have formed during weathering.

Table 1. LA-ICP-MS data for main elements (above detection limit) in three traverses for sample GSWA 201978: gold grain, Silica Hills prospect

Ag (%)	Cu (ppm)	Hg (ppm)	Other elements (ppm) ¹⁾²
19	36	79	
17	37	74	
19	24	78	

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

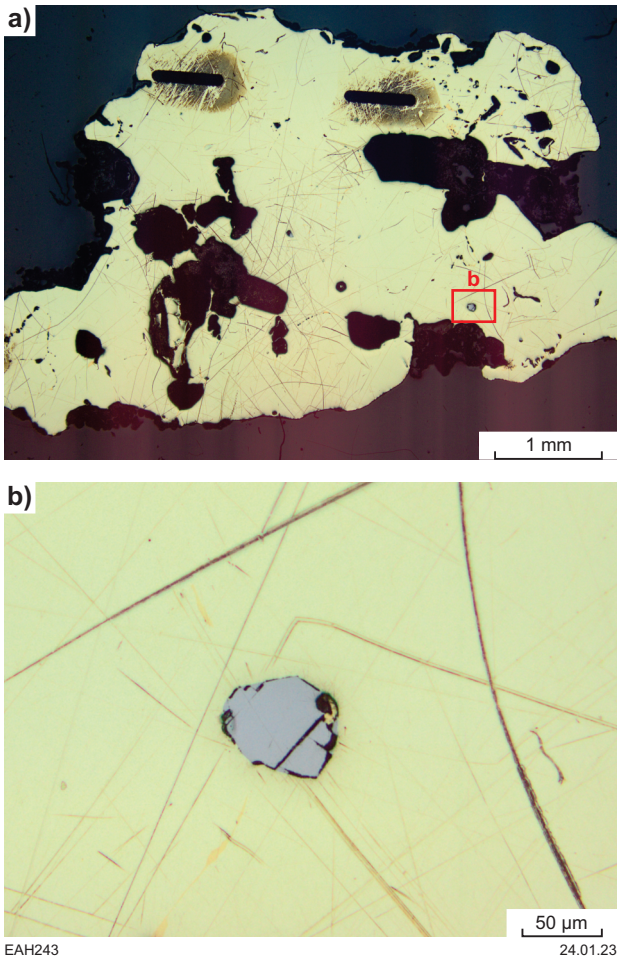


Figure 3. Reflected-light photomicrographs of cut and polished sample 201978: gold grain, Silica Hills prospect. Dark, elongate lines are laser ablation tracks produced during LA-ICP-MS analyses

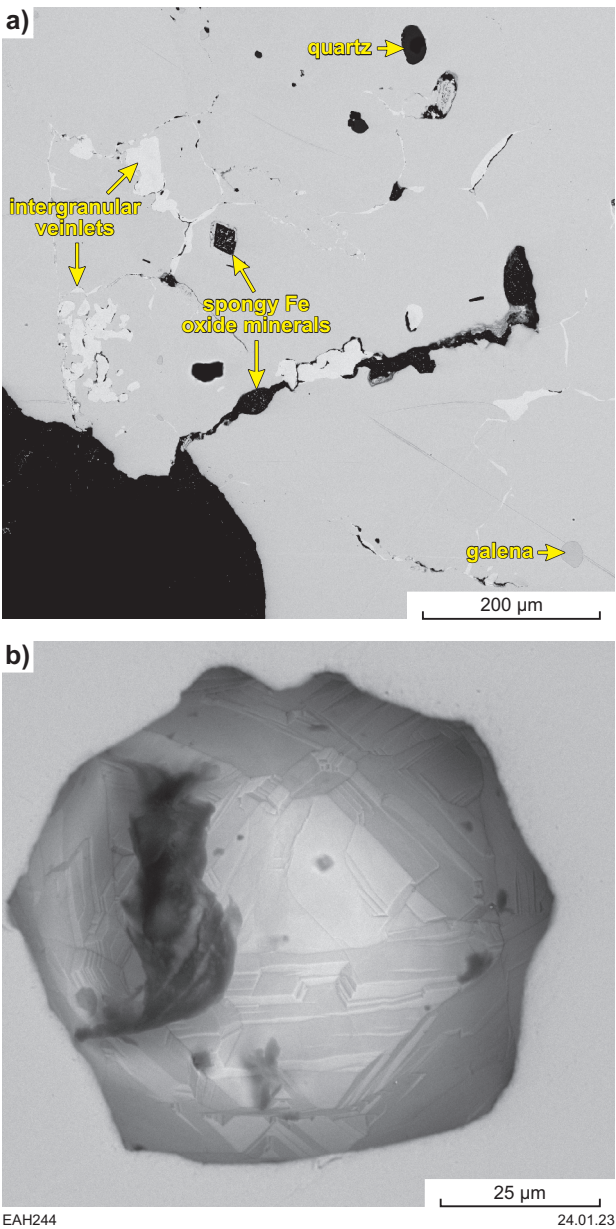


Figure 4. Backscattered electron images of polished surface of sample 201978: gold grain, Silica Hills prospect

Table 2. LA-ICP-MS compositional data for sample GSWA 201978: gold grain, Silica Hills 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	77				7	2	17			2	4	4478
2	cps					36	92				1		5			3		4520
3	cps		2			76	3208				6		1		17			2922
1	ppm					0.54					0.14						0.04	36
2	ppm					0.43					0.02							37
3	ppm					0.90					0.12							24
DL*	ppm					3.3					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	7					5	8	1	1					5	39447644		1
2	cps	8	1		11			2			2				6	35086900		
3	cps	9					5	9	1					1	10	38923839		
1	ppm	0.08													0.03	191401		
2	ppm	0.09			0.13										0.05	170242		
3	ppm	0.10													0.07	188859		
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	9	169	2	3					2	2							
2	cps	23	131			1		1										
3	cps	16	131	5	4	5	1			1					1		1	
1	ppm	0.04	0.66	0.03														
2	ppm	0.10	0.51															
3	ppm	0.07	0.51	0.09														
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					1		22928	1	10	8	1	1			
2	cps								1	21529		9	43					
3	cps									22661		4	19		1			
1	ppm									79		0.03	0.02					
2	ppm									74		0.03	0.09					
3	ppm									78		0.01	0.04					
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 table are quoted as values that are below the detection limit for these analytes. These values must be considered as 'for information' only.

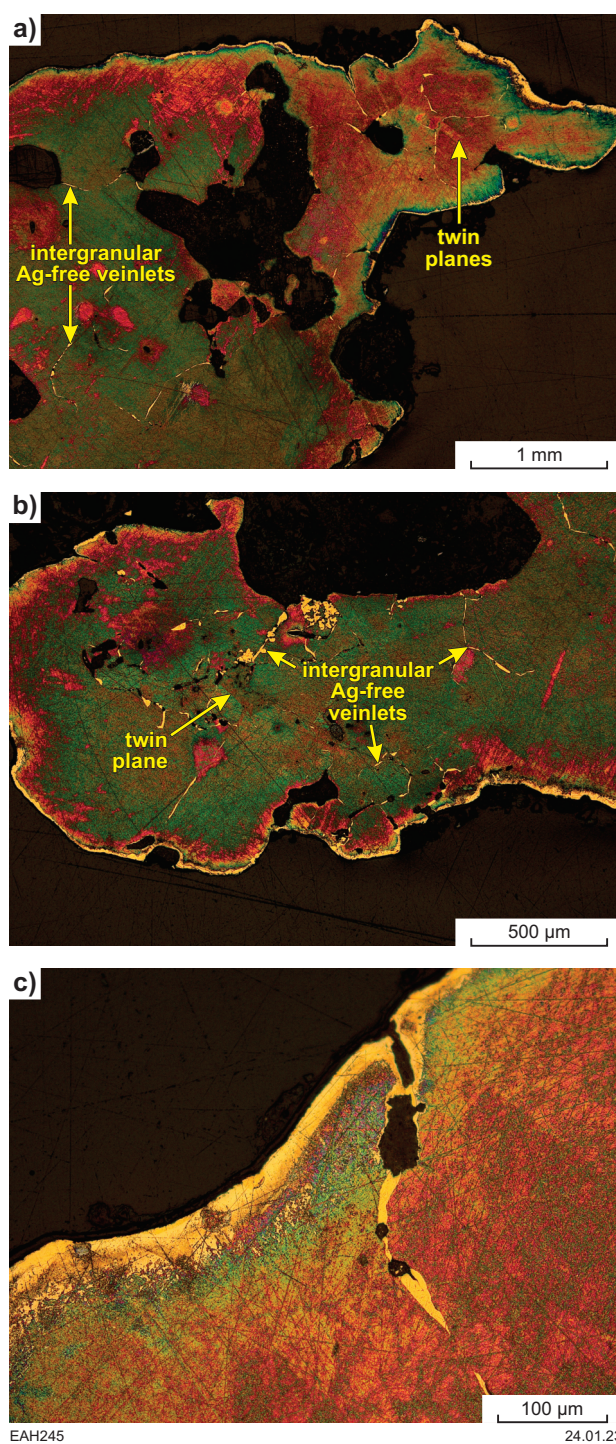


Figure 5. Reflected-light photomicrographs, after repolishing and acid etching, of parts of sample 201978: gold grain, Silica Hills prospect

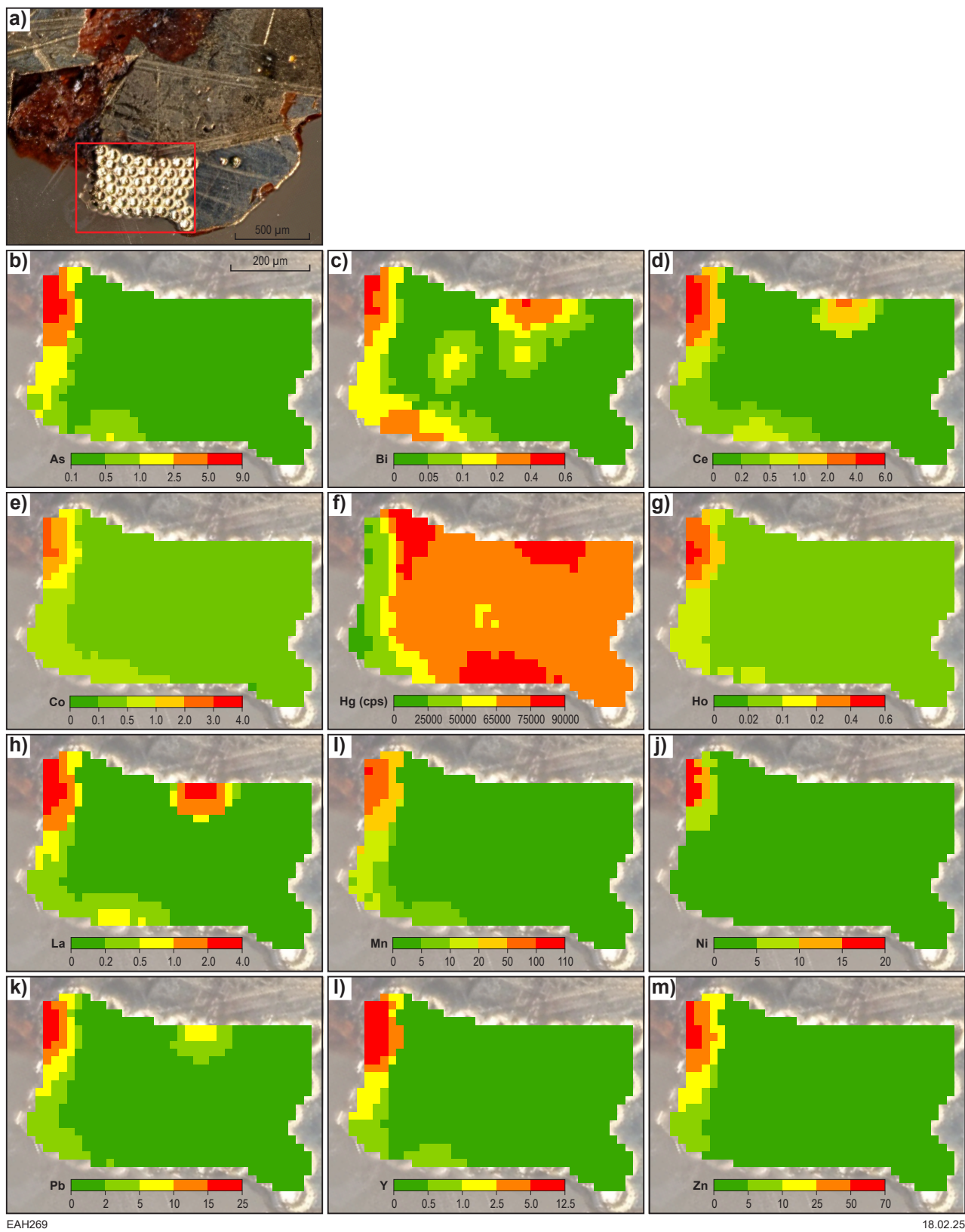


Figure 6. LA-SF-ICP-MS elemental maps of selected elements (in relative units) in the part of sample 201978: gold grain, Silica Hills prospect

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Recommended reference for this publication

Hancock, EA, Blay, OA and Beardsmore, TJ 2025, 201978: gold grain, Silica Hills prospect; GSWA Mineralogy Record 12: Geological Survey of Western Australia, 7p.

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