Available documentation of Luwu prepared metal samples

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This document collates the available pictographic information on Luwu (South Sulawesi) ore and metal samples prepared as specimens for metallographic analysis by Dr Len Hogan at the University of Queensland Department of Mining and Metallurgical Engineering between 1998 and 2000. The specimens were collected by the author and my Indonesian partner field workers during the course of fieldwork for the Origins of Complex Society in South Sulawesi (OXIS) project between 1997 and 1999. The OXIS project was hosted at the Australian National University Department of Archaeology and Anthropology, with the author and Dr Ian Caldwell, then of the University of Hull, as Chief Investigators (Bulbeck and Caldwell 2000 – see http://arts.anu.edu.au/bullda/oxis_homepage.html). Funding for the fieldwork and laboratory work including that undertaken at the University of Queensland was funded by a large Australian Research Council grant.

The main objective of the OXIS project was to investigate the shadowy origins and pre-Islamic to early Islamic history of the Bugis kingdom of Luwu. Luwu was the first South Sulawesi kingdom to embrace Islam (in 1603) and is reputed to be South Sulawesi's oldest kingdom. The suspected basis of Luwu's early pre-eminence is its control over high-quality ('weapons grade') iron products, including the famed *pamor luwu* of Majapahit Java, manufactured from iron ore sources in Luwu. The OXIS project successfully documented habitation and burial sites at Luwu's palace centre at Malangke between the fourteenth and early seventeenth centuries, but also found evidence for exploitation of Luwu's iron ore sources going back to the first millennium CE.

Regrettably Dr Hogan passed away before he could complete his metallurgical analysis. In fact, the whereabouts of 10 specimens of iron knives and other artifacts from various Luwu sites, sent to Dr Hogan, can no longer be traced, and he did not have the opportunity to prepare them as specimens for analysis before his decease. (No further reference to these specimens is made in this document.) However, Dr Hogan did manage to produce a number of reports, which the author collated and scanned, and emailed to Dr Christian Reepmeyer and Dr Oliver Pryce as a PDF in June 2012. There are also brief references to Dr Hogan's findings in the descriptions of the OXIS sites in Bulbeck and Caldwell (2000).

All materials collected in the field during the OXIS project were transported to the Balai Arkeologi Makassar office in Makassar, South Sulawesi. These include very large quantities of iron-smelting waste and suspected hearth remains from Matano (Rahampu'u 1 and Pandai Besi) where the main excavations of iron-smelting deposit occurred. To the author's knowledge, all of these materials remain curated at Balai Arkeologi Makassar except those sent to Dr Hogan and a selection of flaked chert, earthenware pottery and other materials stored at Canberra for ongoing analysis.

Not all of the collected specimens were photographed or sketched before being submitted for metallographic analysis, especially the samples that Dr Hogan selected himself during his visit to South Sulawesi in 1998. In these cases the documentation below presents the provenance of the samples in question.

Part 1: Iron ore samples

Site/location	Specimen ID	Fieldwork (laboratory) identification	Work undertaken	Specimen provenance
Lamalengko	124	Iron ore (ironstone)	SEM, qualitative spectral analysis	ANU
Lembo-Lembo	4561	Iron ore	Specimen prepared	ANU (2 specimens)
Katue KTE.0.3	4231	Iron ore	Specimen prepared	ANU
Passauen PSN.0.1–2	4240	Iron ore	Specimen prepared	ANU (2 specimens)
Kamiri KMR.0.1–2	4246	Iron ore	Specimen prepared	ANU
Sabbang Loang SBL.1-4.17.1	5076A	Ironstone	Specimen prepared	ANU
Sabbang Loang SBL.1-4.19.2	5089A	Ironstone (ironstone)	SEM, qualitative spectral analysis	Cf. 5089B?
Sabbang Loang SBL.1-4.19.51	5089B	Iron-coated gravel	Specimen prepared	ANU

Table 1: Luwu iron ore samples

Bukit Lamalengko (Lamalengko Hill) is the ethnohistorical iron ore source for the ironworkers at Matano (west end of Lake Matano). On 20 April 1998, local guides took OXIS fieldworkers to an area with hundreds of holes for ore extraction in dense forest in the vicinity of 2°25’48”S 121°13’4”E. Two blocks of iron ore weighing 817 grams were collected from the surface. One block was taken as a sample by Len Hogan in 1988 while the other block was left at Balai Arkeologi Makassar. There are no pictographic records of the iron ore blocks or collection site.

Lembo-Lembo is the ethnohistorical iron ore source for the ironworkers at Nuha (north shore of Lake Matano). On 27 April 1999, a local guide took OXIS fieldworkers to a swidden garden area with numerous holes for ore extraction at 2°26’42”S 121°15’18”E. Eight lumps of ironstone weighing 2.077 kg were collected from the surface. Two lumps (Plate 1) were sent as samples to Len Hogan in 1989 while the other six were left at Balai Arkeologi Makassar. The collection site was photographed but no prints can currently be located.

Katue is an open site strung along the north bank of the tidal stretch of the Cerekang River, covering an area of around 0.6 hectares, located at 2°35’25.1”S 121°02’00.5”E. The site was identified in June 1998 after inspection of the drainage ditches dug through the site by the landowner revealed large quantities of earthenware pottery in the ditch banks. Nine square-metre test pits within and riverside of the site yielded two sets of radiocarbon dates, which respectively reflect first millennium CE habitation and light gardening use over the last 400 years. Habitation activities include suspected smelting of iron ore transported overland from Lake Matano (Bulbeck and Caldwell 2000). On 10 February 1999, a specimen described in the accession register as ‘Nickeliferous iron ore lump’ (KTE.0.3, accession number 4231) was collected from the surface of the site 2 metres north of Square 1, within the perimeter of the habitation area. The specimen was not photographed, sketched or weighed before being dispatched to Len Hogan. Plate 2 includes two photographs of the approximate location of the collected specimen.

Plate 1: Lembo-Lembo ironstone samples (two views)


Plate 2: Katue cacao orchard and drainage ditches near where specimen KTE.0.3 was collected

Luwu's other ethnohistorical source of iron ore was Limbung, on the upper Rongkong River, and more specifically the Bukit Porreoq and Bukit Pangiwangen hills within the Limbung district. The present writer inspected two ethnohistorical ore smelting sites on 21 and 22 November 1997, and learned that the Porreoq and Pangiwangen ore was blended there to produce Limbung's renowned weapons-grade iron. After this visit, follow-up fieldwork at Limbung was not feasible because heavy rains in the highlands washed away the access road.

The author collected four specimens of iron ore (Plates 3–4, which also show an iron ore sample from Sabbang Loang). The first two, from the site of Passauen (2°34'36"S 119°54'6"E), were collected from a pathway exposure that also contained burnt earthenware sherds (some with the appearance of crucible rims) and singed glass. These two specimens (PSN.0.1–2, accession number 4240), which together weighed 66.8 grams, were locally identified as Bukit Porreoq iron ore. The second two specimens, from the site of Kamiri (2°35'12"S 119°56'18"E), were collected from the surface of a soccer field bordered by features locally identified as the remnants of an ironworking shed, a locality where iron ore was crushed with large stones, and a slag heap. These two specimens (KMR.0.1–2, accession number 4246), which together weighed 101.8 grams, were locally identified as Bukit Pangiwangen iron ore.

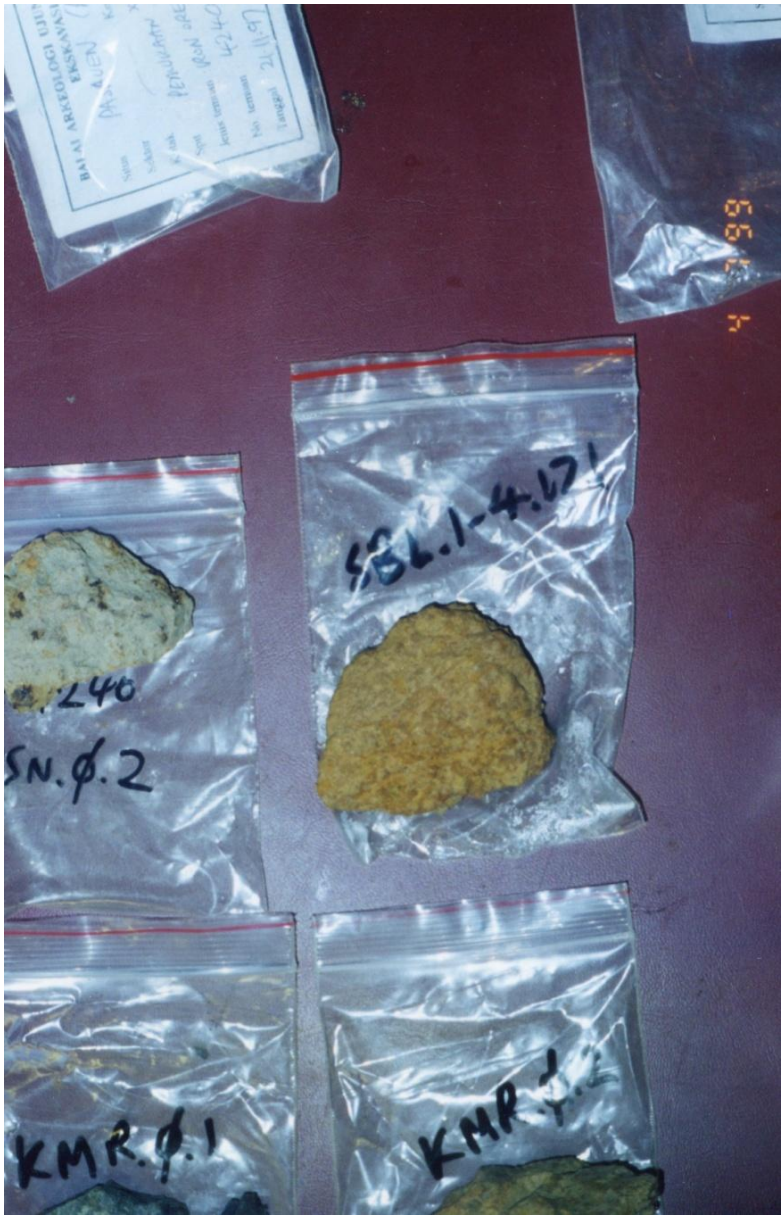

Plate 3: Iron ore samples from Passauen (middle left), Kamiri (below) and Sabbang Loang (middle right)

Plate 4: Iron ore samples from Passauen (middle left), Kamiri (below) and Sabbang Loang (middle right)

Three samples of ‘ironstone’ from the site of Sabbang Loang (2°35’43.1”S 120°14’46.6”E) are present among the prepared specimens. Sabbang Loang is located where the Rongkong River meets the Luwu coastal plain, and the ironstone is suspected to have been transported from Limbung down the Rongkong to Sabbang Loang. Several radiocarbon determinations date initial habitation at Sabbang Loang to the early centuries CE, including one determination from the jar burial found in association with the Sabbang Loang ironstone specimens and an obsidian flake (Plate 5). However, clear evidence for roasting or smelting iron ore has not been recovered from the Sabbang Loang excavations.

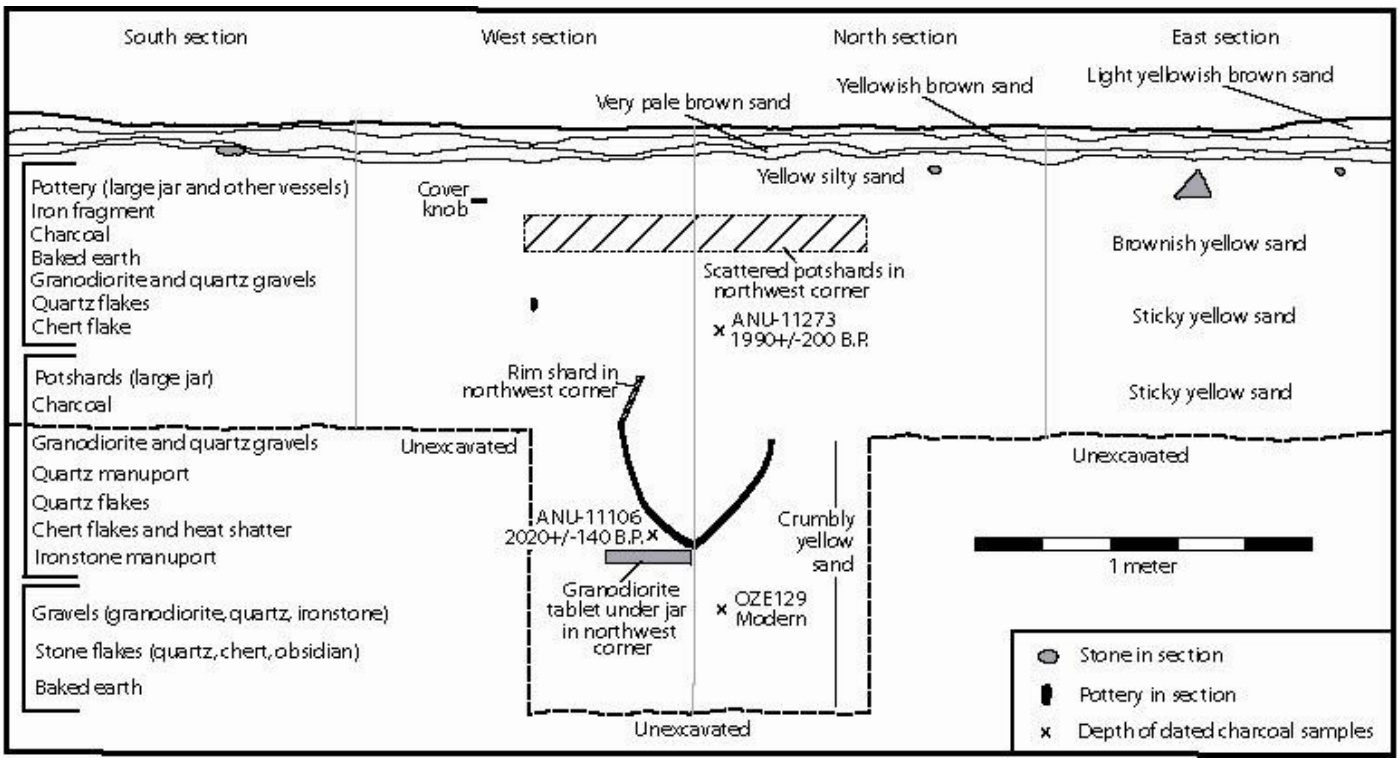

Plate 5: Stratigraphy of Sabbang Loang square 1–4, showing approximate provenance of iron specimens (spits 17 and 19)

The ironstone specimen SBL.1-4.17.1 (accession number 5076A) is the “ironstone manuport” in the left-hand explanatory test to Plate 5. It was weighed at 62.4 grams (Plates 3 and 4) before being sent to Len Hogan in June 1999. The other two ironstone specimens, SBL.1-4.19.2 and SBL.1-4.19.51 (accession numbers 5089A and 5089B), are the ironstone gravels referred to in Plate 5. They respectively weighed 1.5 and 12.3 grams. The identification of SBL.1-4.19.2 was confirmed by Len Hogan’s laboratory analysis. SBL.1-4.19.51 is depicted in Plate 6 (left side).

Plate 6: Two views of Sabbang Loang ironstone specimen (SBL.1-4.19.51) at left, Sabbang Loang iron blade fragment (SBL.3-1.8.1) centre, and Rahampu'u 1 iron blade fragment (RHP1.S6T5.6.122) right

Part 2: Iron slag/fragment samples from Matano village

Matano village at the western tip of Lake Matano is celebrated in local ethnohistory as the main producer of Matano iron. The presumed source of its iron ore is Bukit Lamalengko. Three iron smelting sites were excavated by OXIS, called Rahampu'u 1 (= First House, 2°27'20.4"S 121°13'00.0"E), Pandai Besi (= Skilled at Iron, 2°27'24.2"S 121°12'57.7"E) and Lemogola (2°27'14.5"S 121°13'00.8"E) – four square metres at Rahampu'u 1 and a single square metre at Pandai Besi and at Lemogola. A suite of radiocarbon dates date iron smelting at Rahampu'u 1 and Pandai Besi to between the fifteenth and seventeenth centuries and at Lemogola to around the eighteenth and nineteenth centuries (Bulbeck and Caldwell 2000). The

deposit at Rahampu'u 1 and Pandai Besi is thick with black slag containing thousands of flaked chert artefacts, and Rahampu'u 1 additionally has masses of baked clay (interpreted as furnace lining) along with earthenware tuyères (also identified at Lemogola).

Five collected samples from Rahampu'u 1 have been prepared and three analysed by Len Hogan; of the six collected and prepared from Pandai Besi, three have been analysed; while all four collected samples from Lemogola have been analysed (Table 2). Two additional samples from a surface survey of Matano village have not been analysed.

Site/location	**Speci-men ID**	**Fieldwork (laboratory) identification**	**Work undertaken**	**Specimen provenance**
Rahampu'u 1 RHP1.S6T5.5.1	158A	Ironstone (bloomery slag)	Optical micrographs + SEM, qualitative spectral + quantitative X-ray analysis	ANU
Rahampu'u 1 RHP1.S6T5.14.1	512A	Iron aggregate (bloomery slag)	Optical micrographs + SEM, qualitative spectral analysis	ANU
Rahampu'u 1 RHP1.S6T5.15.2	526	Limestone gravel with copper oxide coating	Specimen prepared	ANU
Rahampu'u 1 RHP1.S6B10.5.1–2	184A	Iron prills (nickel-rich ferritic iron)	Optical micrographs + SEM, qualitative spectral analysis	ANU
Rahampu'u 1 RHP.0.1	4220	Tuyère with iron slag	Specimen prepared	ANU
Pandai Besi PDB.U1T3.4.1	643A	Iron artefact fragment (amorphous slag)	Optical micrographs + SEM, qualitative spectral analysis	ANU
Pandai Besi PDB.U1T3.5.1	646A	Ironstone (bloomery slag)	Optical micrographs + SEM, qualitative spectral analysis	ANU
Pandai Besi PDB.U1T3.8.55	888A	Iron slag (iron ore fragment)	Optical micrographs, qualitative spectral analysis	ANU
Pandai Besi PDB.U1T3.8.54	890	Iron conglomerate	Specimen prepared	ANU
Pandai Besi PDB.U1T3.9.48	897	Iron conglomerate	Specimen prepared	ANU
Pandai Besi PDB.U1T3.8.56	885	Copper/iron smelting product	Specimen prepared	ANU
Lemogola LMG.1.4.2	704A	Iron slag (iron silicate – fayalite)	Optical micrograph, qualitative spectral analysis	ANU
Lemogola LMG.1.4.3–4	707A	Iron fragments (iron silicate slag)	Optical micrographs + SEM, qualitative spectral + quantitative X-ray analysis	ANU (3 specimens)
Lemogola, LMG.1.5.1	713A	Iron slag (bloomery slag)	SEM, qualitative spectral analysis	ANU
Lemogola LMG.1.9.1	812A	Iron slag (bloomery slag)	Optical micrographs + SEM, qualitative spectral analysis	ANU
Matano MTN.T74.2	866	Sherd with iron slag	Specimen prepared	ANU
Matano MTN.T34.11	820	Copper/iron slag	Specimen prepared	ANU

Table 2: Prepared slag and iron fragment samples from Matano village, Lake Matano

Rahampu'u 1

Sample RHP1.S6T5.5.1 (Rahampu'u 1, accession number 158A) was selected by Len Hogan from 2.5 kg of 'ironstone' excavated in the fifth unit of the S6T5 square (Plate 7). The remainder of the ironstone sample (accession number 158B) is stored at Balai Arkeologi Makassar.

Plate 7: Rahampu'u 1 square S6T5, end of excavation of unit 5

The excavation of square S6T5 proceeded down past a subterranean stone wall (house foundations postdating iron smelting at the site) which was left in place as units were excavated to the sides of the wall. From one such unit, unit 14 (indicated by the arrow in Plate 8), Len Hogan selected a fragment of iron aggregate (RHP1S6T5.14.1, accession number 5128A) from the 5.5 kg excavated in this unit. The remainder (accession number 5128B) was left at Balai Arkeologi Makassar.

Plate 8: Rahampu'u 1 square S6T5, end of excavation of unit 14

The next unit from the S6T5 square yielded sample RHP1. S6T5.15.2 (Rahampu'u 1, accession number 526) a limestone gravel, weighing 1.7 grams, with a blue coating suspected to be copper oxide (Plate 9). The specimen was sent to Len Hogan, who prepared it for metallurgical analysis.

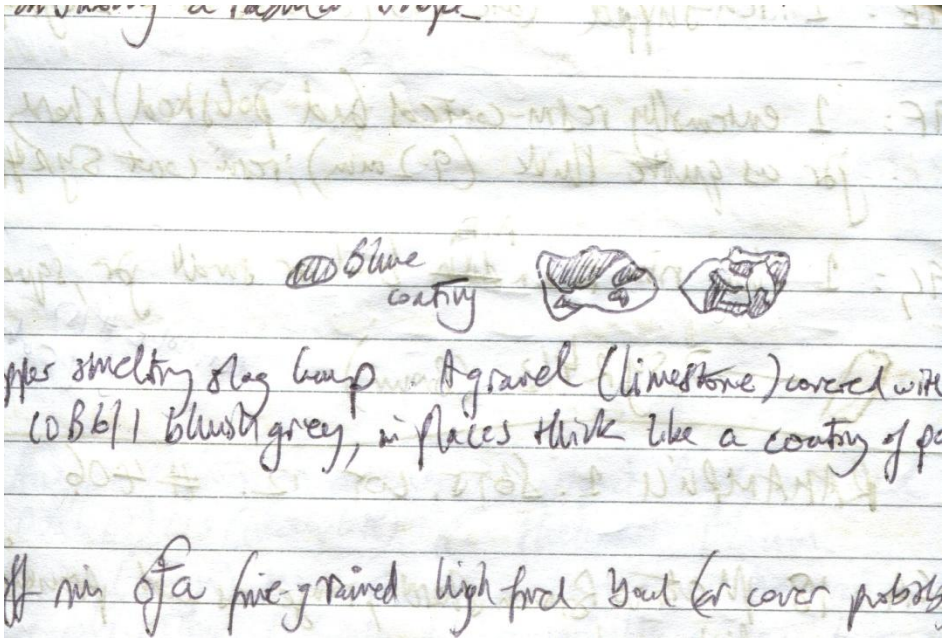

Plate 9: Scan of laboratory sketch of RHP1. S6T5.15.2 specimen (not to scale)

Sample RHP1.S6B10.5.1–2 (Rahampu'u 1, accession number 184A) consists of 2 iron prills, weighing 0.1 grams, selected by Len Hogan from 0.5 grams of iron prills excavated in the fifth unit of the S6B10 square (Plate 10). The other 2 iron prills (accession number 184B) are stored at Balai Arkeologi Makassar.

Plate 10: Rahampu'u 1 square S6B10, end of excavation of unit 5

The final slag/fragment specimen from Rahampu'u 1 is a surface find collected on 9 February 1999 and identified in Indonesia as a tuyère fragment with a metallic coating. The specimen (RHP1.0.1, accession number 4220) was not weighed, sketched or photographed before being sent to Len Hogan, who prepared it for metallurgical analysis.

Pandai Besi

The Pandai Besi specimen PDB.U1T3.4.1 (accession number 643A) was identified in Indonesia as an iron artefact fragment but shown by Len Hogan's analysis to be amorphous slag. It was found in unit 4 (Plate 11).

Plate 11: Pandai Besi square U1T3, end of excavation of unit 4

The next unit yielded 95 lumps of 'ironstone' weighing 1.1 kg, of which one (PDB.U1T3.5.1, accession number 646A) was selected by Len Hogan for analysis. At unit 7 the excavation ran into a black iron conglomerate layer (Plate 12). In unit 8, 10 lumps identified as iron slag, weighing 103 grams, were excavated. One of these, weighing 50 grams (PDB.U1T3.8.55, accession number 888A), was selected for analysis by Len Hogan, while the remainder was left at Balai Arkeologi Makassar accession number 888B). A lump from the same unit identified as iron conglomerate containing flaked chert (strike-a-lights?), weighing 60 grams, was sent to Len Hogan for metallurgical analysis (PDB.U1T3.8.54, accession number 890) after removal of the flaked chert. Another lump of iron conglomerate containing flaked chert, from unit 9 (PDB.U1T3.9.540, accession number 897), was also sent to Len Hogan after removal of the flaked chert embedded in it.

Plate 12: Examples of the iron conglomerate blocks at Pandai Besi, units 7 (shown here) to 12

The last specimen from Pandai Besi that was sent to Len Hogan is a suspected iron-copper smelt conglomerate (Plate 13, right side). This specimen, weighing 19.7 grams, was excavated in unit 8 (PDB.U1T3.856, accession number 885).

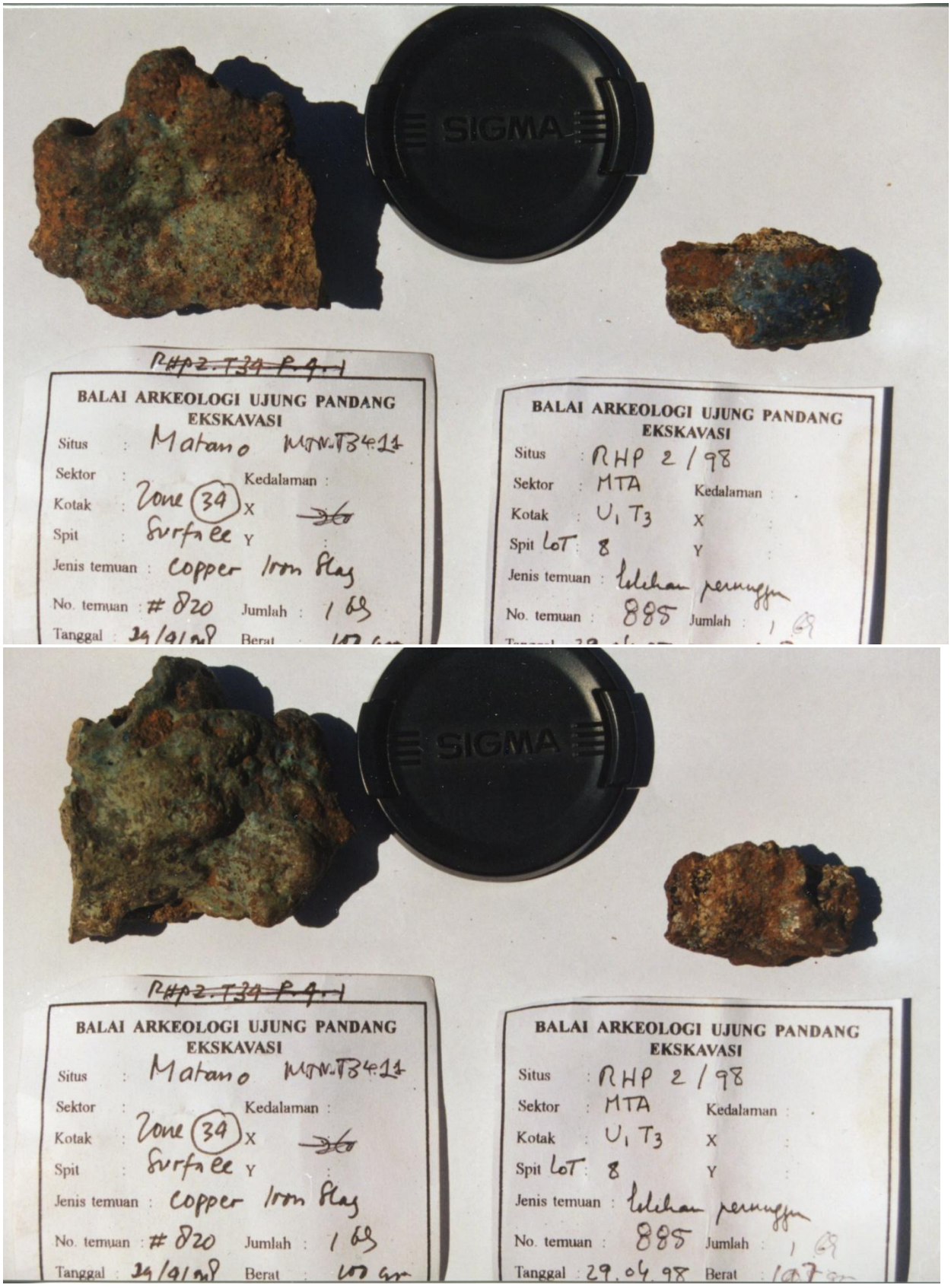

Plate 13: Two views of suspected copper/iron smelt fragments from Matano – MTN.T34.11 (surface find, left) and PDB.U1T3.8.56 (excavated from Pandai Besi, right)

Lemogola

The excavation at Lemogola came upon a hardened earth floor, presumably hardened from exposure to high heat. Unit 4 was taken down to where the hard floor feature started, and Unit 5 was excavated to the point where the hard earth floor covered the entire test pit (Plates 14 and 15). Further excavation came upon a hard yellowish layer entered by depressions, whose excavated deposit was labelled unit 9 (Plate 16).

Plate 14: Lemogola square 1, excavation at end of unit 4

Plate 15: Lemogola square 1, excavation at end of unit 5

Plate 16: Lemogola square 1, excavation at end of unit 9

Two samples from unit 4, one from unit 5 and one from unit 9 were selected by Len Hogan for metallurgical analysis. LMG.1.4.2 comprised 15 iron slag fragments, weighing 150 grams, of which one specimen (accession number 704A) was studied by Len Hogan, while the other 14 fragments (accession number 704B) remain stored at Balai Arkeologi Makassar. LMG.1.4.3–4 refers to two flat iron fragments, weighing 0.8 grams, both of which were analysed by Len Hogan (accession number 707A). LMG.1.5.1 refers to 50 grams of iron slag, of which 10 grams (accession number 713A) were selected by Len Hogan for analysis, and the remaining 40 grams (accession number 713B) remain at Balai Arkeologi Makassar. LMG.1.9.1 refers to 29 lumps (150 grams) of iron slag, of which one lump (accession number 812A) was selected by Len Hogan, leaving the other 14 lumps (accession number 812B) at Balai Arkeologi Makassar.

Matano surface collection

The surface of Matano kampong, from the lake shore to the earthen fortifications at the west, were mapped over two days, and divided into zones for collection of imported ceramics, decorated pottery and other noteworthy artifacts. One such collection involved 2 Qing blue-and-white sherds (10 grams) coated with iron conglomerate from zone 74 on the shore of Lake Matano below the Lemogola excavation (Plate 17). One of these sherds (MTN.T74.2, accession number 867) was sent to Len Hogan, who prepared the iron conglomerate for metallurgical analysis.

The second surface collection was a copper/iron slag from zone 34 (c. 100 grams), also sent to Len Hogan (MTN.T34.11, accession number 820). The specimen (Plate 13, left) is described in my laboratory notes as having varying intensities of melted copper run over most of the surface, sometimes as sparse veins, sometimes as a thin coat (5BG 4/6, moderate blue green), covering basal iron slag (5YR 4/4, moderate brown). One face (the bottom one in Plate 13) shows vesicles than can penetrate deep into the iron.

Plate 17: Iron conglomerate on the shore of Lake Matano, zone 74 of Matano kampong survey

Part 3: Iron slag/fragment samples from Lake Matano north shore and Katue

Excavation of the test pit at Nuha (2°26'46.2"S 121°20'22.7"E) proceeded through suspected iron smelting deposit dated approximately to between the eighteenth (unit 3) and tenth century CE (unit 15) – see Plate 18. Two samples from the excavation were sent to Len Hogan and prepared by him for metallurgical analysis.

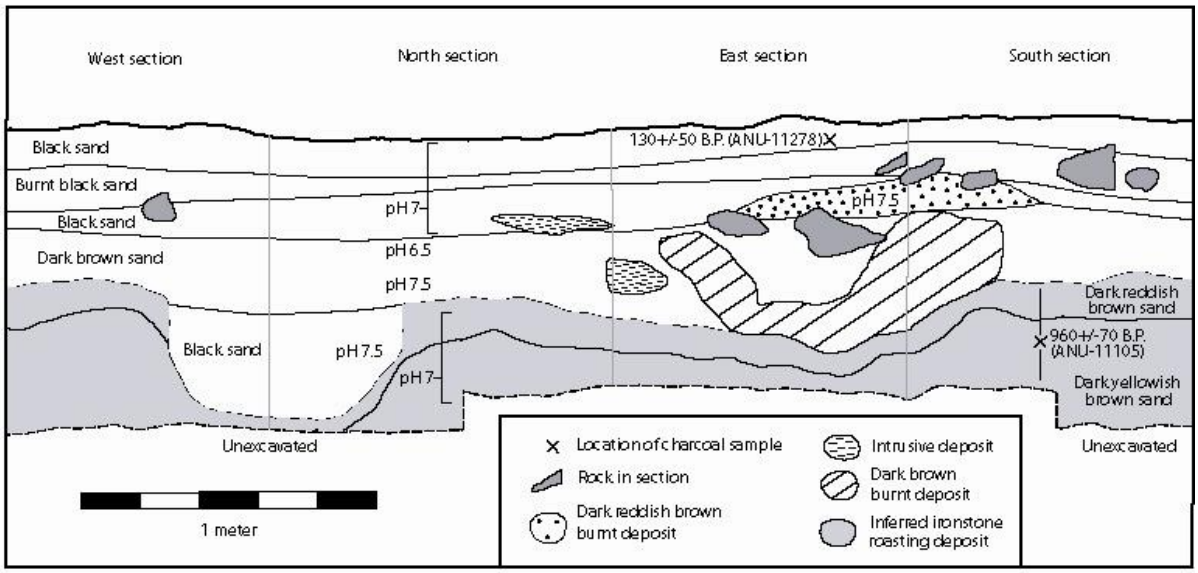

Plate 18: Stratigraphy of Nuha test pit 1

Site/location	Specimen ID	Fieldwork (laboratory) identification	Work undertaken	Specimen provenance
Nuha NUH.1.7.1	4597A	Potsherd + iron slag	Specimen prepared	ANU
Nuha NUH.1.12.1	4628	Iron fragment + slag	Specimen prepared	ANU
Katue KTE.2.9.18–19	2816A	2 iron prills	Specimen prepared	ANU

Table 3: Prepared slag and iron fragment samples from Nuha and Katue

The sample from unit 7 (NUH.1.7.1, accession number 4597, Plate 19), in the thick of the smelting deposit, consisted of 6 pottery sherds with adhering iron slag. The largest sherd weighing 16.7 grams (accession number 4597A) was the one sent to Len Hogan, while the other 5 sherds (accession number 4597B, weight 22.2 grams) remain stored at Balai Arkeologi Makassar.

Plate 19: Pottery sherds with adhering iron slag, Nuha test pit 1, unit 7

Plate 20: Excavation of unit 12, feature penetrating the dark reddish brown sand at Nuha, test pit 1

The second specimen from Nuha (NUH.1.12.1, accession number 4628), was identified as a flat iron piece with adhering slag, weighing 2.3 grams. The specimen was recovered from the unit 12 feature beneath the main Nuha smelting deposit (Plate 20).

The two iron prills from Katue (KTE.2.9.18–19, accession register 2816A) weighed 0.7 grams. They were described in my laboratory notes as having an uncorroded appearance and a dark reddish brown surface colour (Munsell 5YR 3/2–3/3). A sketch of them has been published in Bulbeck (2010: Figure 2); the original illustration is reproduced below (Plate 21).

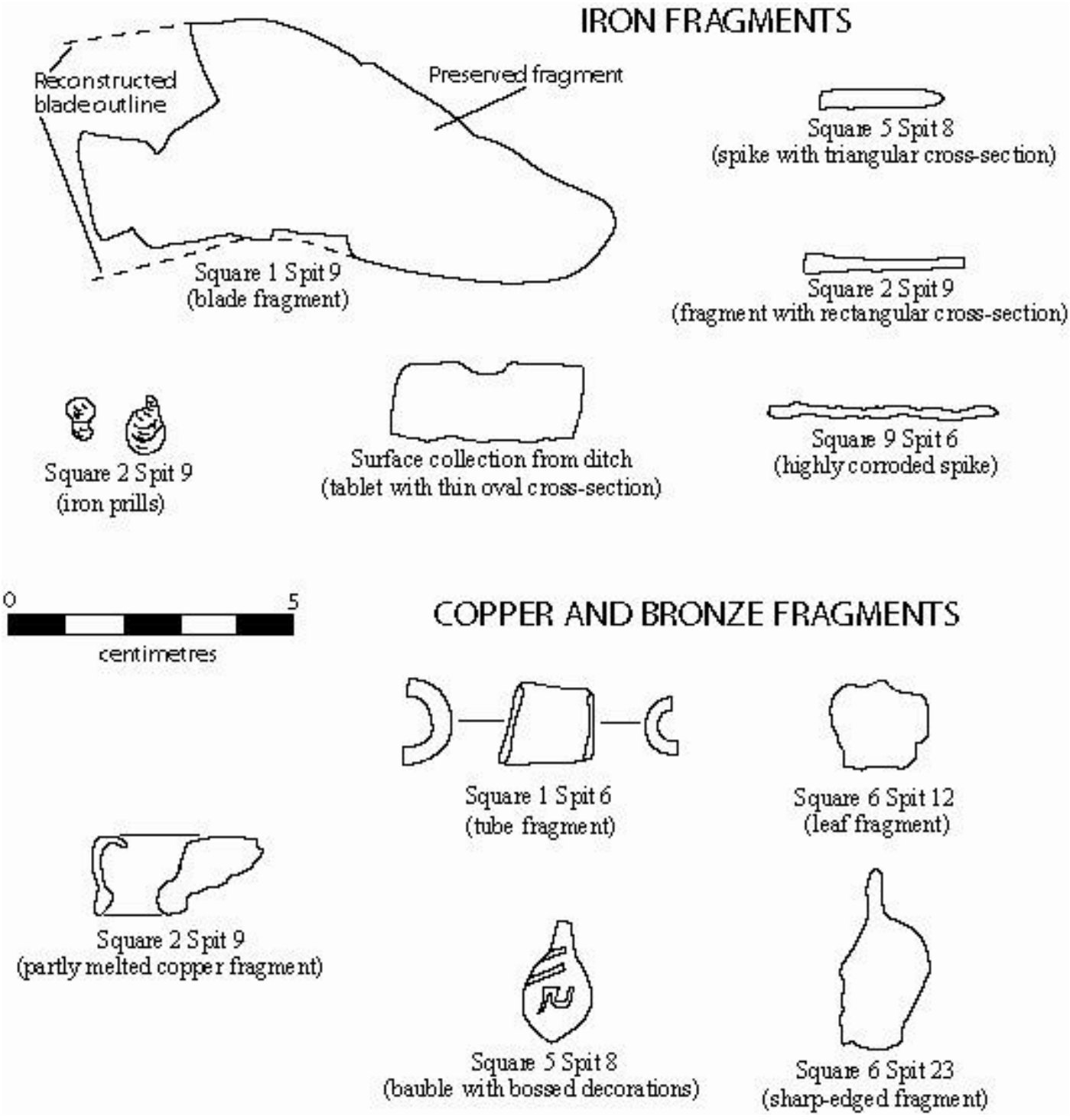

Plate 21: Katue metal specimens including KTE.2.9.18–19 (iron prills) and Katue KTE.1.6.5 (tube fragment)

Part 4: Iron slag/product samples from Pinanto (2°35'10.4"S 120°15'31.6"E)

Pinanto, located on the Rongkong River near Sabbang Loang, was excavated with a series of test pits each 15 metres along a north–south transect through the site (Bulbeck and Caldwell 2000). It is dated to the fifteenth to seventeenth centuries from the imported ceramics and a radiocarbon determination. The Pinanto samples are suspected to represent local iron smithing on ore transported overland in early historical times from the Limbung iron ore sources (see Passauen and Kamiri specimens above).

Site/location	Speci-men ID	Fieldwork (laboratory) identification	Work undertaken	Specimen provenance
Pinanto PNT.U61B7.10.1	1664	Baked clay lump mixed with iron	Specimen prepared	ANU
Pinanto PNT.U121B15.4.1	1745B	Iron slag (iron reduction product)	SEM, qualitative spectral analysis	ANU
Pinanto PNT.U121B15.4.2	1746A	Iron prills (metallic iron + aluminium silicate)	Optical micrographs, qualitative spectral analysis	ANU

Table 4: Prepared slag and iron fragment samples from Pinanto

The PNT.U61B7.10.1 specimen (accession number 1664) was recovered from a shallow feature in habitation deposit (Plate 22). It was identified as possibly a lump of baked clay mixed with iron, or else corroded iron, and weighed at 10 grams before being sent to Len Hogan on 27 October 1998.

Plate 22: Pinanto square U61B7; end of excavation of unit 10

The PNT.U121B15.4.1 and PNT.U121B15.4.2 specimens were recovered from a shallow deposit with evidence of ironworking (Plate 23). PNT.U121B15.4.1 included 10 fingers of iron slag, weighing 13.1 grams, of which one (accession number 1745B) was confirmed by Len Hogan to represent ironworking. The other 9 slag specimens (accession number 1745A) remain at Balai Arkeologi Makassar. PNT.U121B15.4.2 included 4 iron prills, of which 2 (accession number 1746A) were identified as metallic iron by Len Hogan. The other 2, which weigh 0.1 grams, remain at Balai Arkeologi Makassar (accession number 1746B).

Plate 23: Pinanto square U121B15; end of excavation of spit 4

Part 5: Metal artefact samples

Site/location	Speci-men ID	Fieldwork (laboratory) identification	Work undertaken	Specimen provenance
Rahampu'u 1 RHP1.S6T5.5.2	159	Iron fragment (imported steel)	Optical micrographs, qualitative spectral analysis	ANU
Rahampu'u 1 RHP1.S6T5.6.122	164	Iron spearhead fragment	Specimen prepared	ANU
Rahampu'u 1 RHP1.S6B10.18.1	541	Iron artifact fragment (sand grain)	Optical micrographs + SEM, qualitative spectral analysis	ANU
Katue KTE.1.6.5	2545	Iron or bronze tube	Specimen prepared	ANU
Sabbang Loang SBL.3-1.8.1	1247	Iron blade fragment	Specimen prepared	ANU
Sabbang Loang SBL.1-4.4.3	5015	Iron fragment	Specimen prepared	ANU

Table 5: Prepared samples from Luwu iron artifacts

The fragment of a spoke of imported steel, weighing 0.4 grams, was excavated from unit 5 of the Rahampu'u 1 S6T5 square (Plate 7). Plate 24 shows the excavation plan of where the specimen (RHP1.S6T5.5.2, accession number 159) was excavated. The specimen probably postdates iron ore smelting at Matano and instead belongs to the nineteenth to twentieth century period of iron puddling, as remembered in ethnohistory of Matano as well as Soroako, now a modern mining town of on the south shore of Lake Matano.

The spit below produced an iron spearhead fragment (RHP1.S6T5.6.122, accession number 164) that may be a product of local Matano iron metallurgy. The specimen, weighing 23.1 grams (Plate 6 right), has been prepared for analysis by Len Hogan.

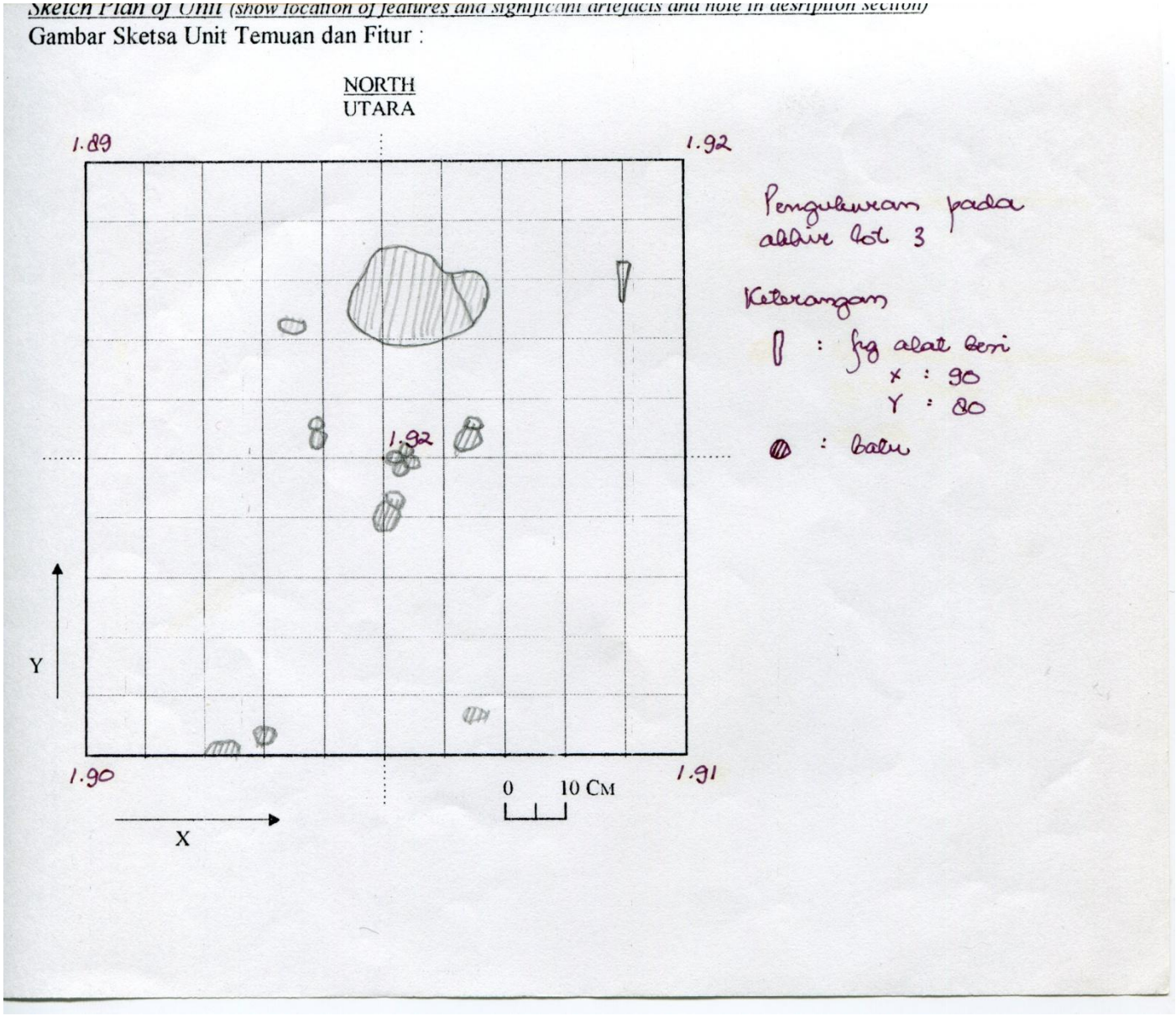

Plate 24: Plan of Rahampu'u 1 S6T5 unit 5 excavation showing location of steel spoke ("frg alat besi")

Specimen RHP1.S6B10.18.1 (accession number 541), also from Rahampu'u 1, was identified as a suspected iron artifact fragment excavated beneath the main iron smelting deposit (weight 10 grams). Len Hogan took it for metallurgical analysis but was unable to confirm its metallic status.

The Katue KTE.1.6.5 tube fragment (accession number 2545) was recovered from first millennium CE habitation deposit. It weighed 1.7 grams, and was described in my laboratory notes as virtually uncorroded, with the hardness of steel, and coloured 2.5YR 4/6 (red) on the surface becoming 5YR 3/3 (dark reddish brown) interiorly. Its extant length was 15.2 mm, thickness of the tube about 1.7 mm, and diameter between 12.1 and 13.5 mm (Plate 21). Whether it is iron or, possibly, copper alloy based should become apparent from metallographic analysis.

Specimens have been prepared of two iron artifact fragments from Sabbang Loang. One of them, from an iron blade (SBL.3-1.8.1, accession number 1247A), is shown in Plate 6 (centre). Its weight of 6.6 grams includes 4.7 grams of artifact, and 1.9 grams of removed corrosion product (accession number 1247B) stored at Balai Arkeologi Makassar. It measured 38.6 mm from its tip (which was trapezoidal in cross-section) to the semi-oval cross-section at the other end, which was 14.2 mm wide and 2.6 mm thick. The

uncorroded colour was 5YR 3/1 (very dark grey) while the corroded surfaces were 5YR 5/6 (yellowish red). It may date to the early centuries CE based on a radiocarbon date of 1910±70 BP (OZD850) from char scraped off pottery sherds excavated in unit 9 of the same test pit, immediately beneath this iron blade specimen.

The second Sabbang Loang artifact specimen (SBL.1-4.4.3, accession number 5015) does not appear to have been photographed or sketched before being sent to Len Hogan. My notes describe it as a fragment of corroded iron weighing 0.3 grams. Its excavated level is indicated in the left-hand explanatory text to Plate 5 as "iron fragment". It lies just beneath the modern debris from this test pit and may relate to the site's main pre-modern habitation period dating to the early centuries CE.

References

Bulbeck, David. 2010. Uneven development in southwest Sulawesi, Indonesia during the Early Metal Phase. In Bérénice Bellina, Elisabeth A. Bacus, Thomas Oliver Pryce and Jan Wisseman Christie (eds.), *50 Years of Archaeology in Southeast Asia: Essays in Honour of Ian Glover*, pp. 152–169. Bangkok: River Books.

Bulbeck, David and Ian Caldwell. 2000. *Land of Iron: The Historical Archaeology of Luwu and the Cenrana Valley. Results of the Origin of Complex Society in South Sulawesi Project (OXIS)*. University of Hull Centre for South-East Asian Studies, Hull.