

Final Report – Probe M

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Introduction and Purpose

Probe M was a 2.5 x 5 meter excavation unit located on the northwestern slope of a small mound in the southeastern part of Khirbat al-Nahas and occupying square GGG27 in the grid established for the site. A 0.5 meter extension to the east into square HHH27 was added during excavation in order to fully define a furnace feature (see page 5). The mound on which the excavation area is located was covered in slag as well as many furnace and tuyere pipe fragments. This indicated that extensive smelting activity took place in this area. The probe was opened in order to perform a systematic archaeological excavation of an intensive smelting area, which has never been done in this region.

Although many similar slag mounds are found throughout the site, this area was chosen for two reasons. One is the presence of what appeared on the surface to be small stone installations that may have been related to smelting activity (see page 2); the other is the close proximity of the area to Area S. It was originally planned that all digital spatial recording would be done with the Total Station used for Area S. This required that the probe be as close as possible to the instrument in order to minimize the amount of error in the spatial recording. However, Probe M was allocated its own Total Station, and this problem was avoided.

Excavation and Recording Techniques

Only the north half of square GGG27 was excavated this season. The wealth of metallurgical remains found in the slag mound precluded the excavation of the entire square. Even this relatively “small” excavation was a challenge in terms of accurately recording the numerous archaeometallurgical remains. Because no such slag mound has been excavated in a systematic archaeological manner in the past, this was done as a trial with the idea that the south half would be better excavated using the knowledge gained from the excavation of the north half. However, given the unexpected slow excavation speed necessary for excavating and understanding this particular area, the south half was never opened.

Initially it was decided that every object (i.e. furnace fragments, tuyere pipes, etc.) would be spatially recorded individually with the Total Station, but the high concentration of these finds found during the surface collection (L. 501) made this method of recording extremely time consuming. It was decided that the bulk of the furnace fragments and tuyere pipe fragments would be collected as general baskets as is done with pottery. Only particularly special or well-preserved pieces were individually spatially recorded.

It was also decided to use the southeast corner of the probe as a control area for measuring the amount of slag in the area as a whole (see page 9). Slag was collected from the entire excavated area and then sorted (large furnace slag, small furnace slag, large tap slag, small tap slag, granule) and weighed. In the 1 x 1 meter control area, however, all of the sediment was sieved, and the sieved material was sorted. All of the slag from this control area was kept, including the very small pieces of crushed slag, and was

subsequently weighed. This method was used in order to provide a better understanding of how much slag of all sizes was found in the area overall.

In order to differentiate the different layers of smelting activity, it was hypothesized that large tap slags would mark the bottom of the smelting layers. This is because the tap slags theoretically form outside of the furnaces during the smelting process when the furnace is opened to extract the copper. Utilizing this model, we were able to determine six distinct smelting layers throughout the excavation area as well as a seventh, lower activity layer of slag crushing.

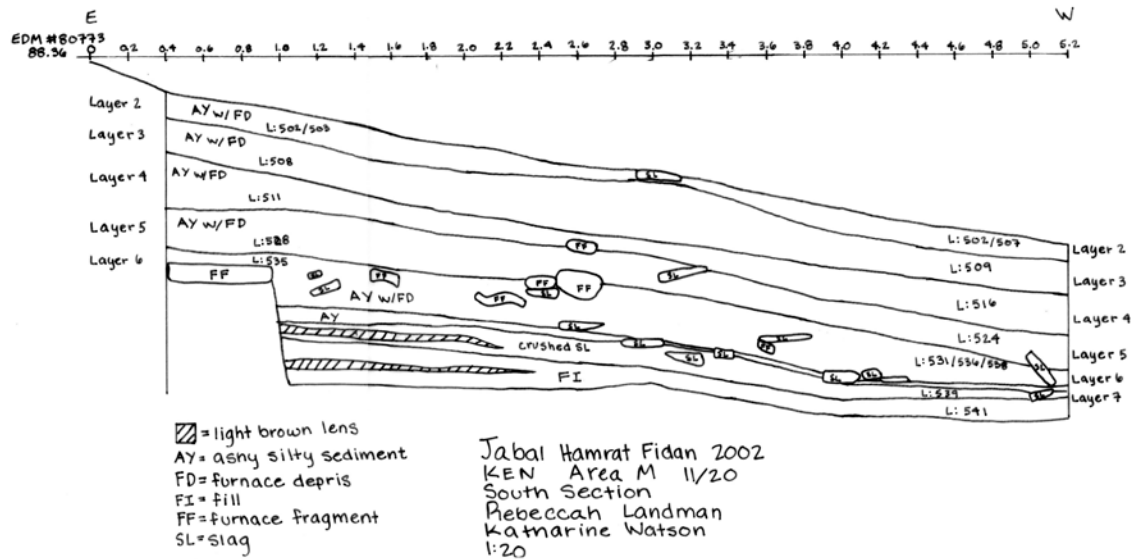
Strata

Four preliminary strata were assigned to the excavated area. Because the area is so small and this is the first season of excavation at Khirbat al-Nahas, it is difficult to definitively link strata with those identified in Area S and Area A. Stratum Ia consists of two small installations, which are probably intrusive into and later than the production layers excavated this season. The production layers, the fill directly underneath them, and the fill and rubble in Room 5 represent Stratum Ib. The occupation layer of Room 5 represents Stratum IIb, which corresponds with the main occupation layer in Area S. The fill under the surface Room 5 represents Stratum III. Again, these are preliminary strata and future excavations may change this assessment.

Stratum Ia (see top plan Stratum 1a, Khirbat al Nahas, Area M)

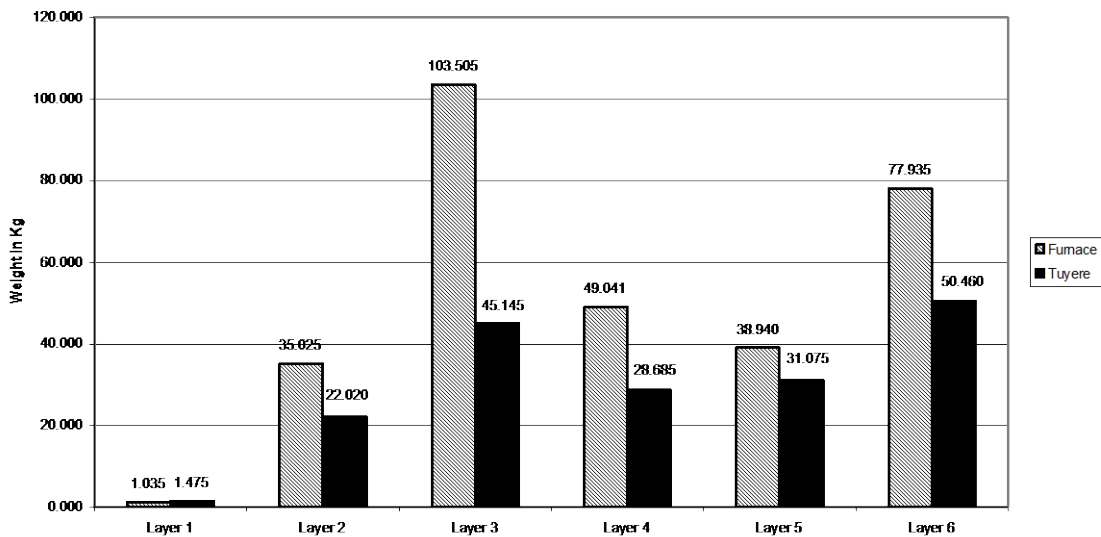
Two small stone installations were discovered on the surface in the northwestern part of the unit. These were excavated as part of L. 506. Note that furnace debris associated with the third layer of smelting activity and located in between these installations and W. 519 was also excavated in this locus. One installation was semi-circular with a diameter of ca. 60 cm. It was made up of 6 stones with one large flat stone in the middle. The stones and material surrounding the installation appear to have been burnt. A hammer stone was found associated with the installation (EDM # 80169) that possibly had charred ore attached to it. Tap slags were found that seem to have been incorporated into this installation. Ca. 20 cm. to the northeast of this installation was a line of five stones (ca. 40 cm. in length) that may have been used as a retaining wall. It appears from the excavation of the furnace debris to the east of the installations that these were later intrusive features, although it is possible that they are associated with a layer of smelting activity (probably the third).

Stratum Ib (see top plan Stratum 1b, Khirbat al Nahas, Area M; south section drawing, square GGG27)



Six layers of smelting activity, one layer of slag crushing material, and a fill layer beneath these were discerned across the entire site. The smelting layers were distinguished by high concentrations of furnace fragments, tuyere pipe fragments, slag, and ash. As mentioned above, tap slags were used to distinguish the bottom of these layers because they form outside of the furnaces during the smelting process. The slag crushing layer was distinguished by a high concentration of crushed slag, a low concentration of metallurgical ceramics, and the presence of a very hard packed layer of crushed slag. The fill layer was distinguished by a relatively low concentration of slag, ash, and metallurgical ceramics, and a higher amount of pottery and bone than in the production layers above.

Tuyere Pipe and Furnace Fragment Weights by Production Layer



Layer 1

The bottom of the first smelting layer was defined by the tap slags located on the surface of the excavation area. Evidence from the first smelting layer was collected in L. 501 and 513.

Layer 2

The second smelting layer was collected in L. 502, 503, 505, 507, 514, and 515. The bottom of the smelting layer was determined by large tap slags. Most of the furnace fragments and tuyere pipe fragments found were fragmented and not very well preserved. The southern part of the probe was somewhat ashier and had a higher concentration of metallurgical ceramics. Many of the furnace fragments were charred and some appear to have been mineralized. Several large fragments were found in situ in the northeastern part of the probe, but these were unfortunately removed before they were properly recorded. These fragments were probably the in situ remains of a furnace that had been broken during the smelting process in order to extract the copper from inside.

Layer 3

The third smelting layer was collected in L. 504, 506, 508, 509, 510, 517, and 518. The bottom of the smelting layer was determined by large tap slags. As in the second layer, there was more ash and a higher concentration of metallurgical ceramics in the southern part of the probe. In the fourth layer, separate loci were opened for the northeastern area and for the southern and western areas in order to show this differentiation.

The northeastern part of the probe was excavated separately (L. 504) in order to attempt to discern more of the furnace that was removed in the locus above (L. 507). This was not possible, but another, better preserved in situ furnace was discovered directly to the south of the first one.



This furnace and the furnace debris directly associated with it was excavated in L. 510. The intact part of the furnace was semi-circular in shape and had an interior diameter of ca. 70 cm. The walls of the furnace were 15-20 cm. in width and preserved to a height of 20-30 cm. The furnace extended into the eastern balk of the probe, so, as mentioned above, the probe was extended ½ meter east into square HHH27 in order to try and define the rest of it (L. 517). The furnace, however, extended only a few centimeters into HHH27. Inside the furnace was an extremely high concentration of furnace fragments with almost no sediment. Under these was an extremely ashy sediment with a very high concentration of charcoal. Some wood was also found and collected (EDM # 80337). The bottom of the furnace was not found probably because it was ripped out after the smelting in order to extract the copper. Large tap slags were found directly under the furnace.

Layer 4

The fourth smelting layer was collected in L. 511, 512, 516, and 526. The bottom of the smelting layer was determined by large tap slags. As mentioned above, separate loci were given for the northeastern (L. 512) and southern and western (L. 516) areas in order to distinguish the difference in ash and metallurgical ceramic concentration between the two (the southern and western areas appeared to have somewhat higher concentrations than the northeastern area).

Layer 5

The fifth smelting layer was collected in L. 522, 524, 526, and 528. The bottom of the smelting layer was determined by large tap slags. The furnace fragments and tuyere pipe fragments in this layer (and the sixth) were larger, less fragmentary, and better preserved than those from the later layers above. In the northeastern area (L. 522) several cut stones were found similar to those used in W. 519 and W. 520. It is possible that these are rubble from W. 520 and represent the destruction of the wall. If this is indeed the case, L. 521, which is fill and rubble inside Room 5 (see page 7) is probably contemporary with the fifth smelting layer.

Layer 6

The sixth smelting layer was collected in L. 523, 529, 530, 531, 535, 536, and 538. The bottom of the smelting layer was determined by large tap slags. Because of difficulties in following the exact layers due to the slope of the unit and the layers within the unit, the western part of L. 531 and 536 probably represented the 5th layer instead of the 6th. Layer 6 was excavated in the western part in L. 538, although again due to difficulties determining the slope of the layers, part of the 5th layer was excavated within L. 538.

Layer 7

Under the sixth smelting layer was a layer of slag crushing activity. This was collected in L. 530, 533, 535, 537, 539, and 540. This layer had a much lower concentration of metallurgical ceramics and an extremely high concentration of crushed slag. A thin layer of ashy sediment with much loose crushed slag was found directly on top of a ca. 5 – 10 cm. layer of extremely hard packed crushed slag. The crushing activity is more prominent in the southern area. There is some evidence in the northeastern part of the probe (L. 533), but none in the northwestern part. Directly under the crushed slag, a significantly greater amount of pottery and bone was found. Also, directly under the crushed slag in the 1 x 1 meter control area (L. 540) a thin lens of decomposed organic material was found. Several large fish vertebrae as well as small pieces of textile (EDM # 80711) were collected from this lens.

A fill layer that does not seem to be directly related to production activities was found under the seventh production layer. This fill was collected in L. 532 (see page 8), 541, 542, and 543. The fill was a medium brown silt with some ash although much less than in the production layers. There was significantly less slag and metallurgical ceramics than in the production layer and more pottery and bone. Because this fill layer marked an end to the first levels of production in the excavation area, all excavation in the probe was ceased after excavating only ca. 10 cm. into this layer.

Stratum IIb (See top plan Stratum 2b, Khirbat al Nahas, Area M)

Stratum IIb coincides with the main occupation layer in Area S. It is represented in Probe M by the corner of Room 5, which is defined by W. 519, W. 520, and the north balk of square GGG27.



It is assumed that Room 5 pre-dates the production layers because of the wall collapse found in the 5th layer of production (see page 6) and the fact that the occupation layer of the room is ca. 1 meter lower than the last production layer excavated.

W. 519 runs from northwest to southeast and meets with W. 520 at its southern end to form the southern corner of Room 5. It is preserved to 8 courses and ca. 1.05 meters in height on its outer side and to 12 courses and ca. 2 meters in height on its inner side. It is ca. 1.90 meters in length and ca. 39 cm. thick. The wall is primarily made of well cut stones that range in from ca. 16 x 11 cm. to ca. 46 x 19 cm. A grinding slab (EDM # 80649) was found on the wall at its northern end. This was probably not part of the original wall, but was placed there later after the wall went into disuse.

W. 520 runs from northeast to southwest and meets with W. 519 at its southern end to form the southern corner of Room 5. It is preserved to 6 courses and ca. 0.95 meters in height on its outer side and to 11 courses and ca. 1.85 meters in height on its inner side. It is ca. 2.06 meters in length and ca. 37 cm. thick. Like W. 519, it is primarily made of well cut stones. The size of the stones ranges from ca. 14.5 x 10 cm. to ca. 57 x 16.5 cm. There is also one very large stone measuring ca. 84 x 30.5 cm.



Both walls appear to have been burnt, and evidence for smelting production extends right up to them. Under the production layers outside of the room, a reddish silt was found adjacent to both walls. This was excavated as L. 532 next to W. 520. There were almost no finds in this locus, and after ca. 10 cm. of excavation, it became very hard packed. It was thought that it could be a surface, but it only extends from the wall 15 – 20 cm. Another possibility is that it is part of a mud brick installation or a mud brick superstructure along the walls. A sample of it from west of W. 519 was collected to be analyzed (EDM # 80744).

Inside Room 5 was a thick layer of a buff, slightly ashy silt with much stone rubble. This probably corresponds with the production layers excavated and may represent the deliberate infilling of the building. Underneath this layer was a reddish silt that was a fill on top of an ashy hard packed surface (L. 525 and 527). This surface corresponds with the bottom of the walls and is probably the only occupation surface for the room.

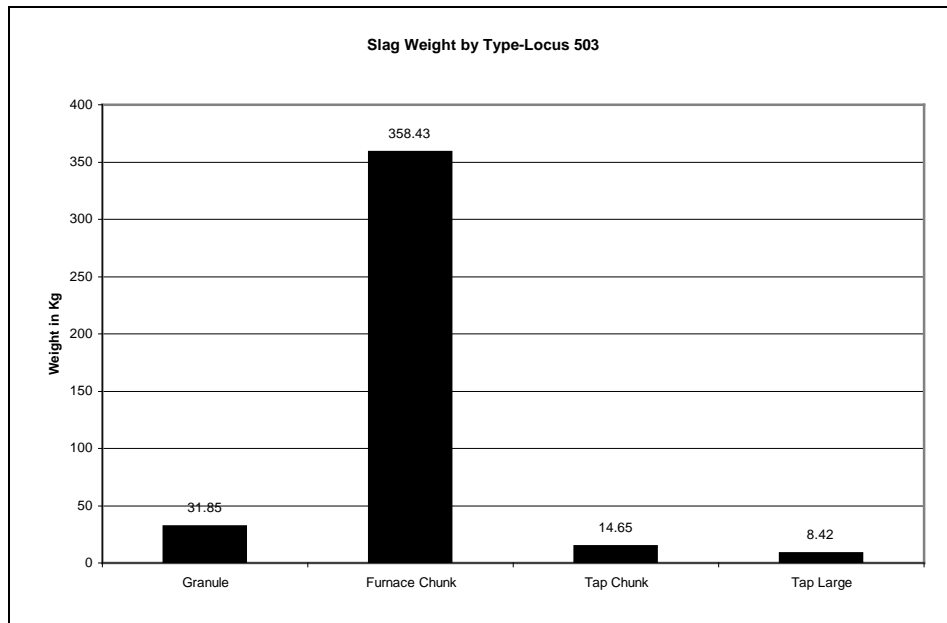
Stratum III

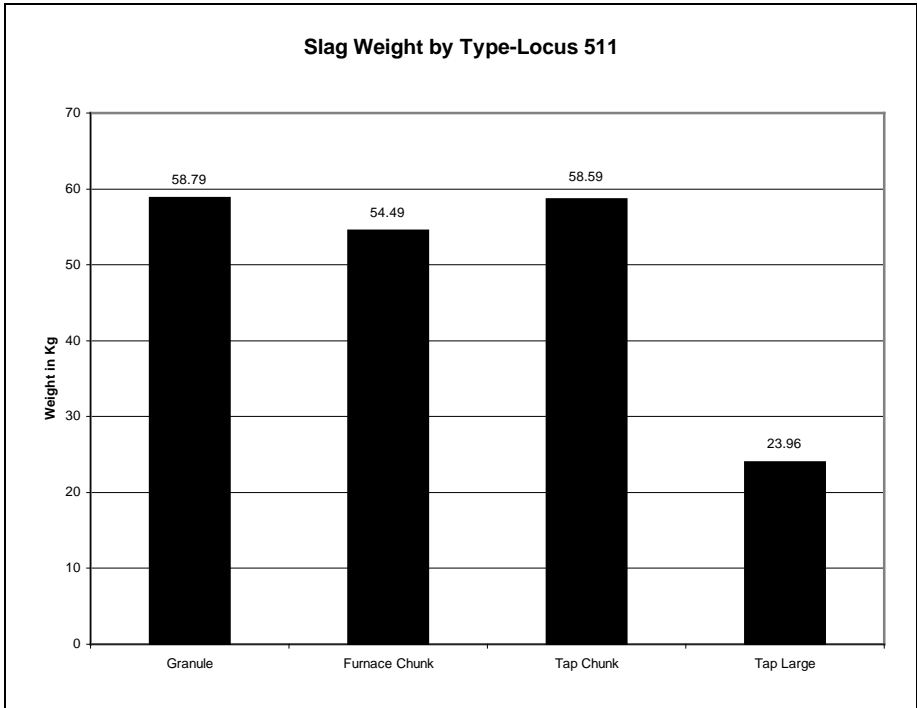
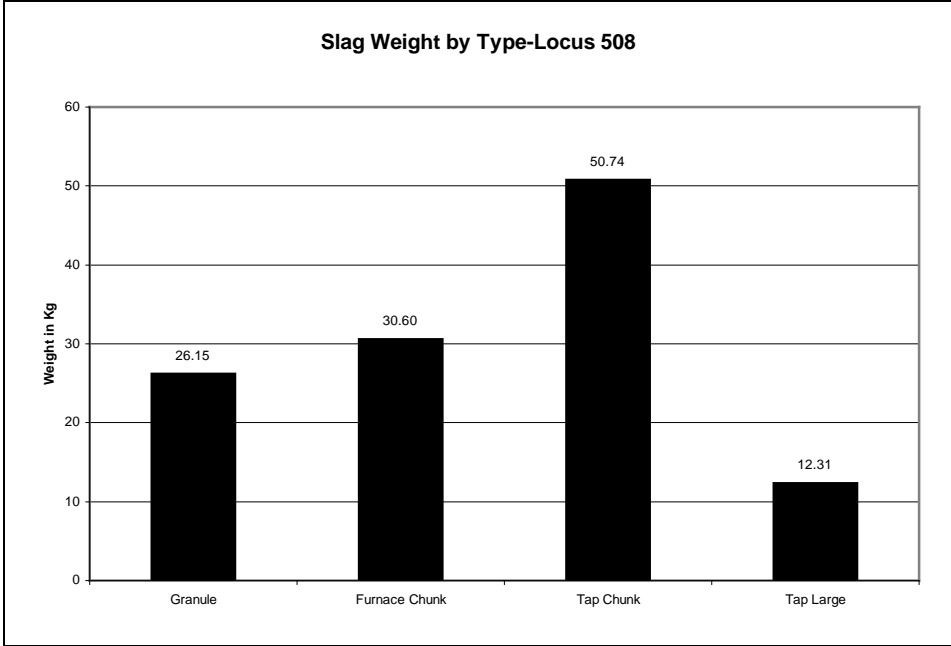
Stratum III is represented by the material under the occupation surface of Room 5. It was collected in L. 534. The fill was very ashy with an extremely high concentration of slag but few other finds. It extended for at least a meter beneath the surface. Excavation was ceased when a large furnace fragment that extended into the north balk made further excavation impossible. Structures in Area S and Area A also appear to be built on a layer of ash and slag.

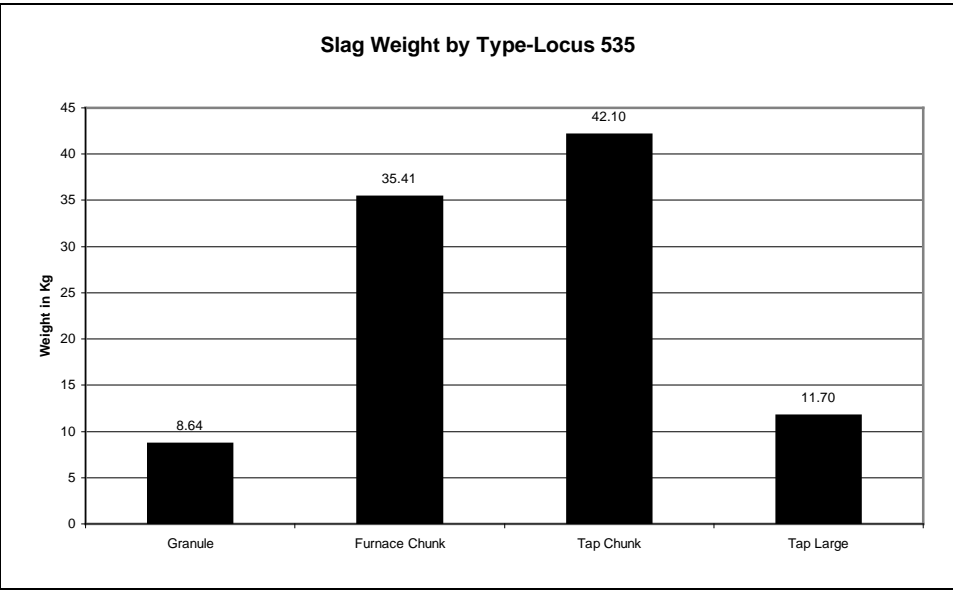
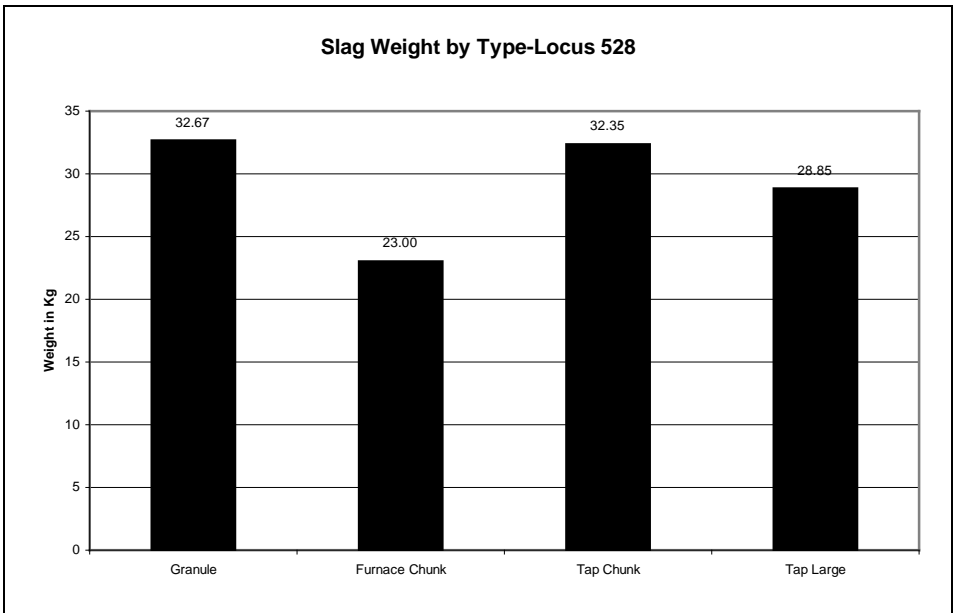
1 x 1 meter control area

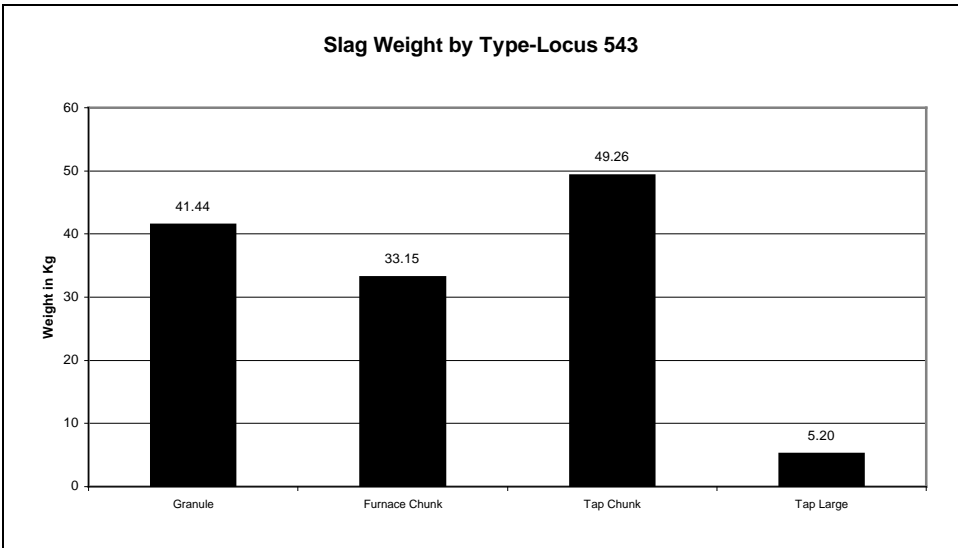
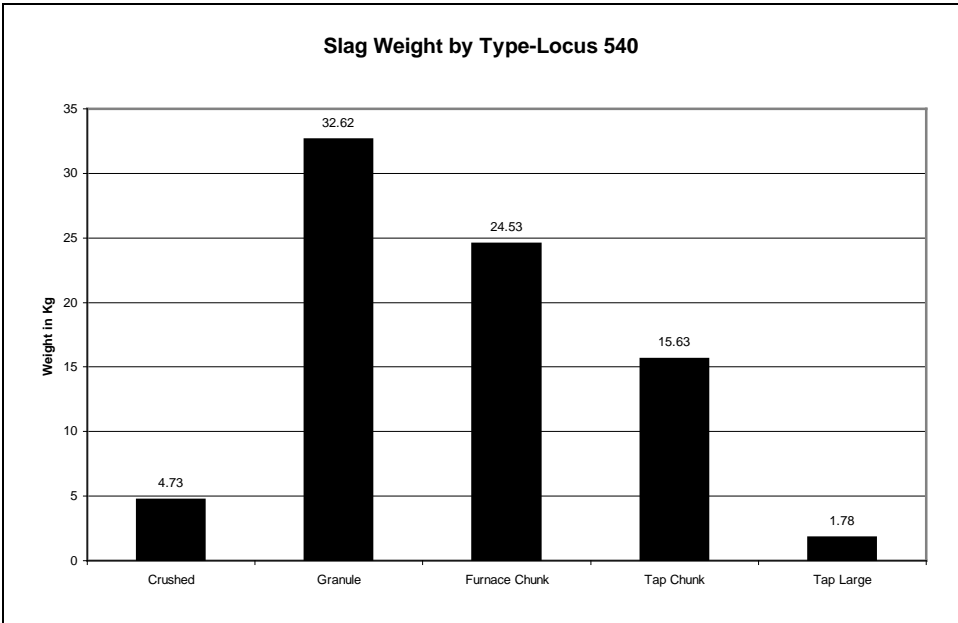
As mentioned above, a 1 x 1 meter control area was opened in the southeastern part of the unit in order to provide a control area for measuring exact amounts of slag, in particular the very small pieces of crushed slag. (Note that in this chart “granule” indicates very small pieces of slag that have been crushed and “crushed” indicates crushed slag that has solidified into a hard packed surface.)

Locus	Crushed	Granule	Furnace Chunk	Tap Chunk	Tap Large
503		31.85	358.43	14.65	8.42
508		26.15	30.6	50.74	12.31
511		58.79	54.49	58.59	23.96
528		32.67	23	32.35	28.85
535		8.64	35.41	42.1	11.7
540	4.73	32.62	24.53	15.63	1.78
543		41.44	33.15	49.26	5.2









Conclusion and Future goals

Our goal of performing a systematic archaeological excavation of an intensive smelting area was met this season. We were able to determine six layers of smelting activity and one layer of slag crushing activity. The high concentrations of furnace fragments and tuyere pipe fragments indicate that this area was used very intensively for smelting.

One of the most important goals for future excavation in this area is to expose the rest of the building represented in Probe M by W. 519, W. 520, and Room 5. The area exposed was not sufficient to determine what purpose it served, but it is clear that this was a well-built, substantial structure. Another important goal is to excavate the probe deeper to determine whether there are more production layers, to reach the level associated with the structure, and also to determine what happened in the levels below the structure.

Another possible goal is to excavate the production layers in the south half of square GGG27. Since this is the first time such an area of intensive smelting activity has been excavated, it was difficult at times to follow the production layers exactly. With the knowledge gained from this season of excavation, the south half could probably be excavated with more control over the different production layers than was achieved this season.