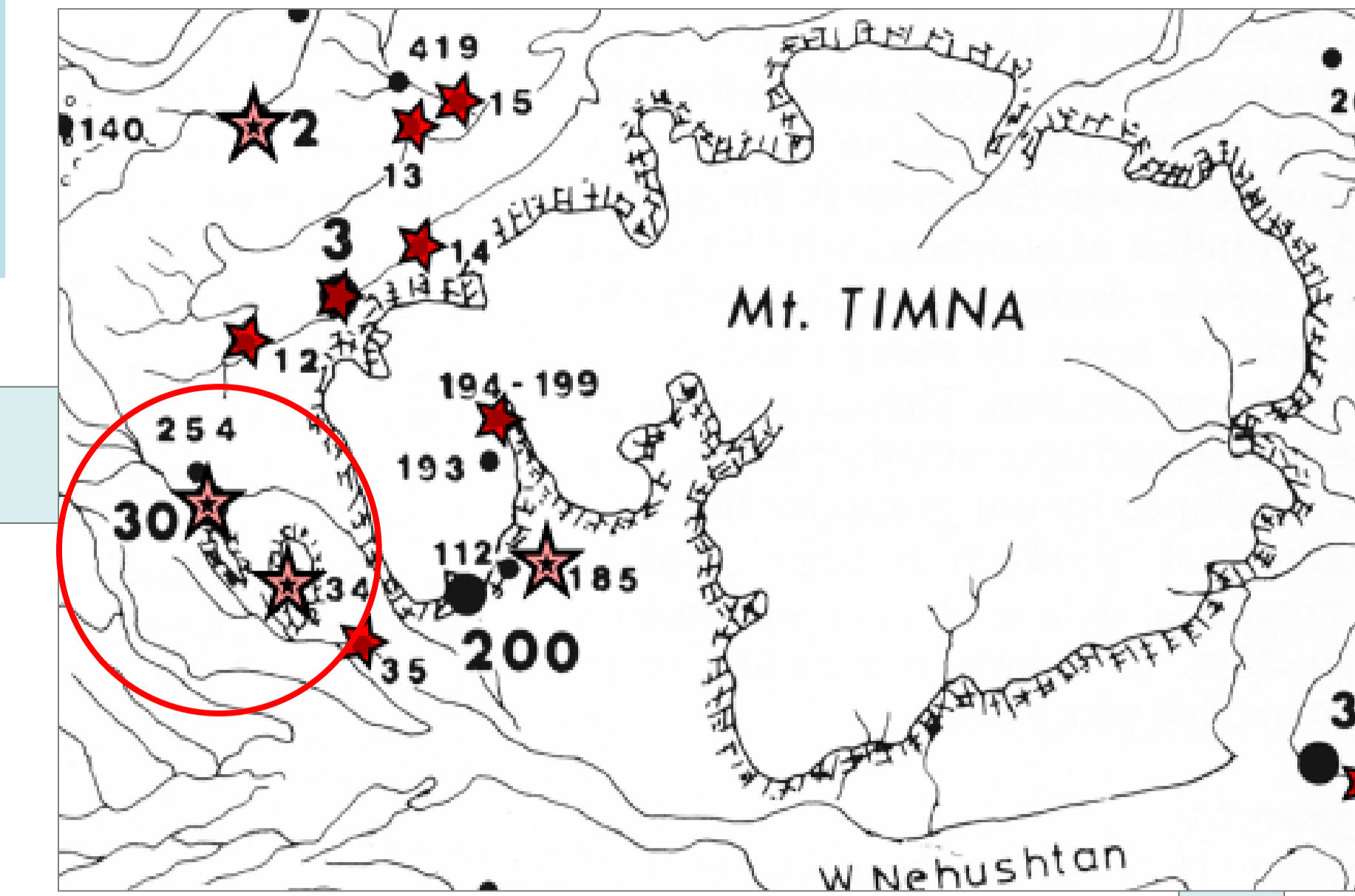


Timna Site 34: Applied Archaeomagnetic Experiments and Excavation

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Location of Site 34 and 30 in the Timna Valley. Site 30a is located on the hilltop of Site 30. Ben-Yosef et al, 2013.



Abstract

As part of the Central Timna Valley Project of Tel Aviv University we conducted archaeomagnetic experiments on slag samples from Site 34 ('Slaves' Hill') and nearby slag deposits in order to further constrain the age of copper smelting in these sites. The experiments focused on reconstructing ancient geomagnetic intensities using the Thellier-Thellier method. The intensity values were compared to the regional archaeomagnetic reference curve and to published values from other sites in the Timna Valley. Intensity values from the hilltop show production during the Iron Age, whereas slag deposits at the bottom of the hill were shown to be from different periods. Results from Site 30a and the hilltop of Site 34 correspond to Beno Rothenberg's theory of intense copper smelting production during the Iron Age in the Timna Valley region.

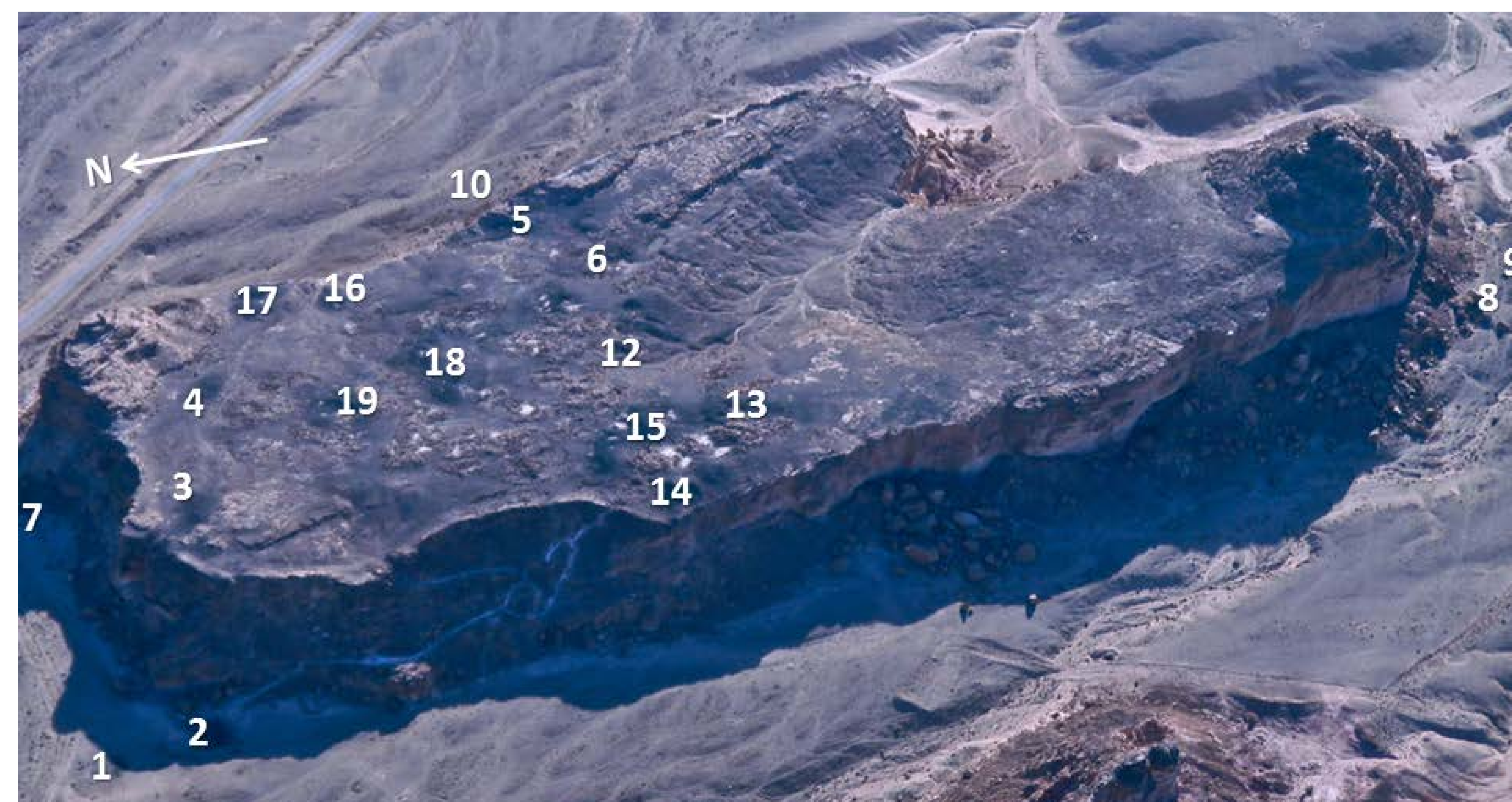
Goals

The project's goal was to further constrain the age of the copper smelting activity which took place at these sites. Archaeomagnetic experimentation was ideal due to the high quantity of ferromagnetic particles in the slag.

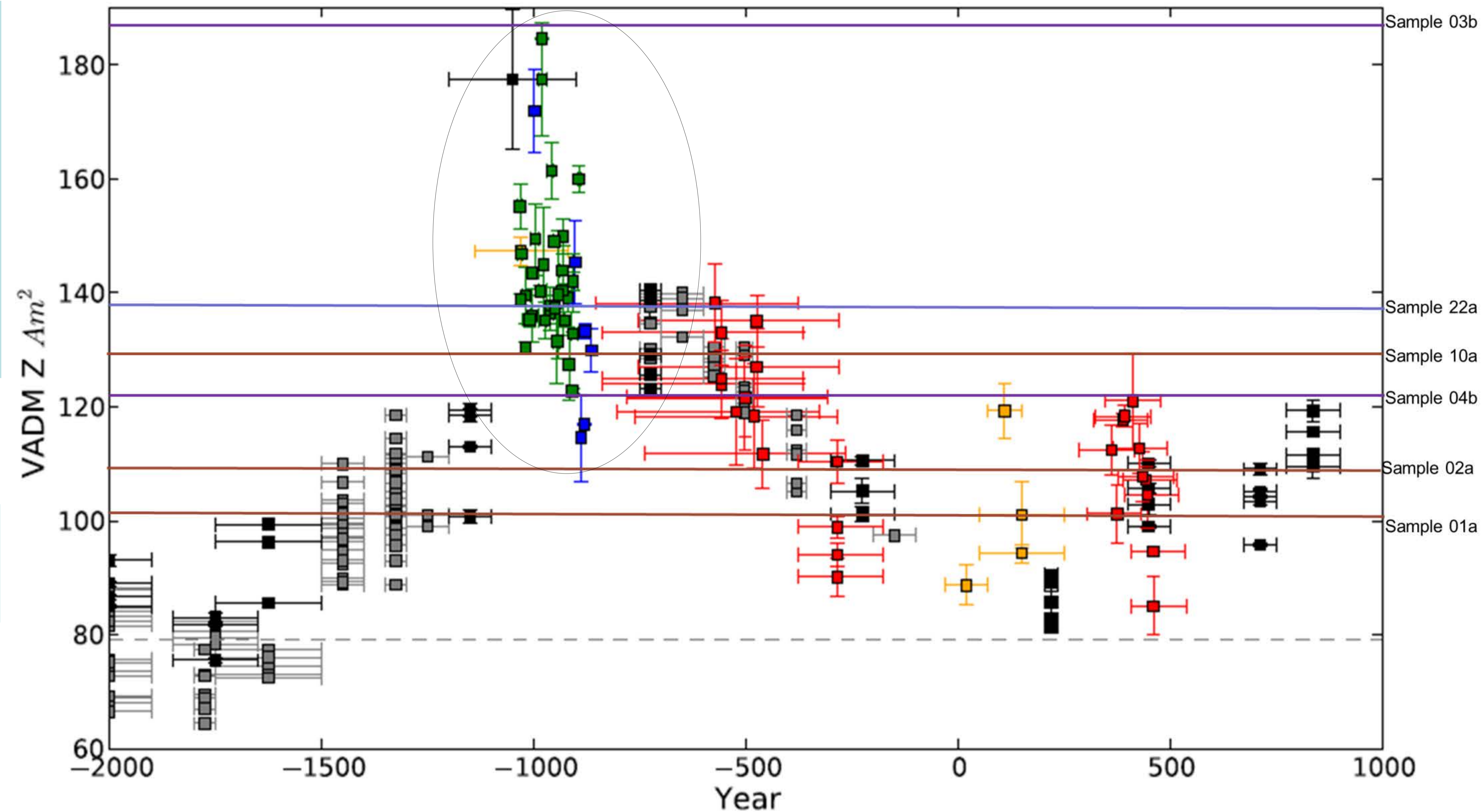
Methods

Slag, a waste product of ancient copper smelting activity is an excellent recorder of the ancient geomagnetic field. As the slag cooled after heating the ferromagnetic particles in the slag would align with the ancient geomagnetic field. Samples from deposits at Timna Site 34 and Site 30a were collected in order to measure their magnetization from which the ancient geomagnetic field is calculated. The slag's ancient magnetization was measured at the Scripps Institution of Oceanography, then compared to new measurements after heating and cooling the slag at known magnetic field strengths (Tauxe and Staudigal's IZZI protocol of the Thellier-Thellier method). After approximately 35 measurements these results were compared and the graphs seen as (A) and (B) were produced.

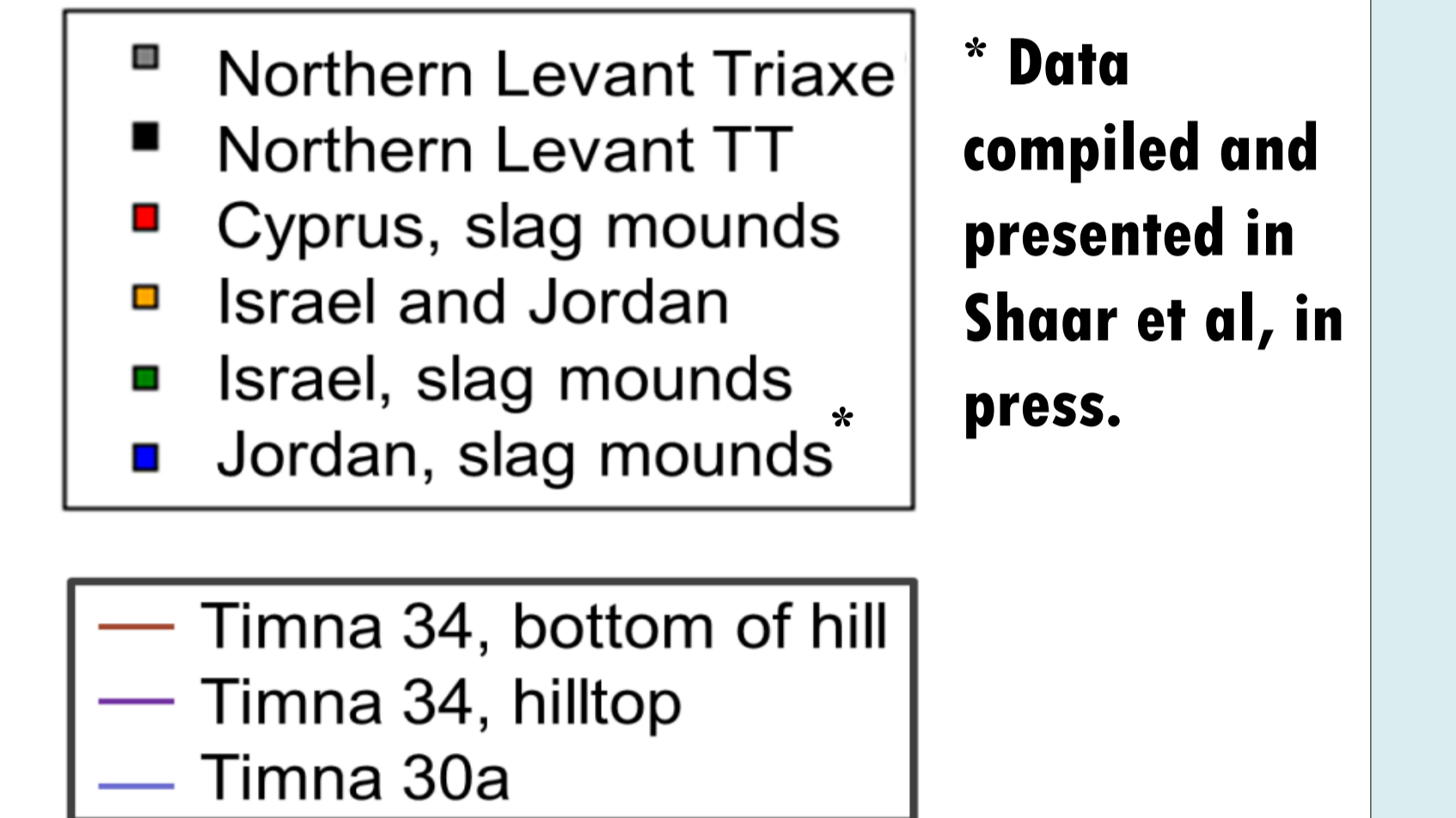
Aerial view of Timna Site 34 with slag mounds numbered



Results



The results from slag pieces that had reproducible results and passed all quality selection criteria are shown plotted in the chart above as horizontal lines. Each square is an archaeomagnetic sample which had been constrained to a very short time period (shown by the horizontal axis). In comparison to previous archaeomagnetic studies, it is seen that the samples from the hilltops (34, 30a) probably have been produced during the Early Iron Age (outlined as a circle), since all lines representing these deposits cross the previous data within this circle. (Later crossings may be excluded due to further archaeological constraints such as slag typology.) Sample 3b's unique archaeointensity value is only seen during the Early Iron Age (the "Iron Age Spike"). Samples from the bottom of the hill cross the previous data at several different periods. Sample 10a was produced during the Early Iron Age whereas Sample 01a and 02a have low results consistent with the Late Bronze Age and Early Islamic geomagnetic field.

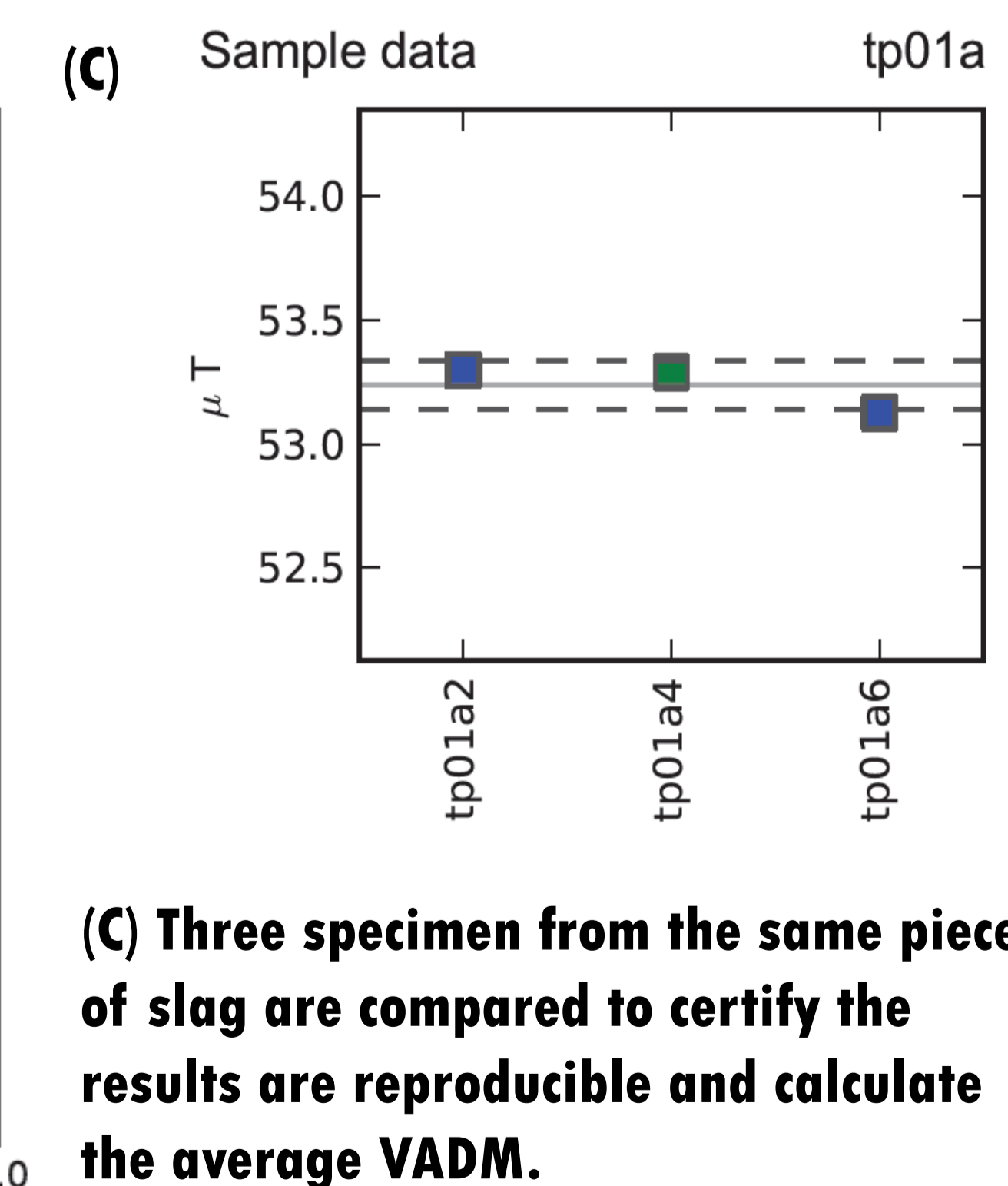
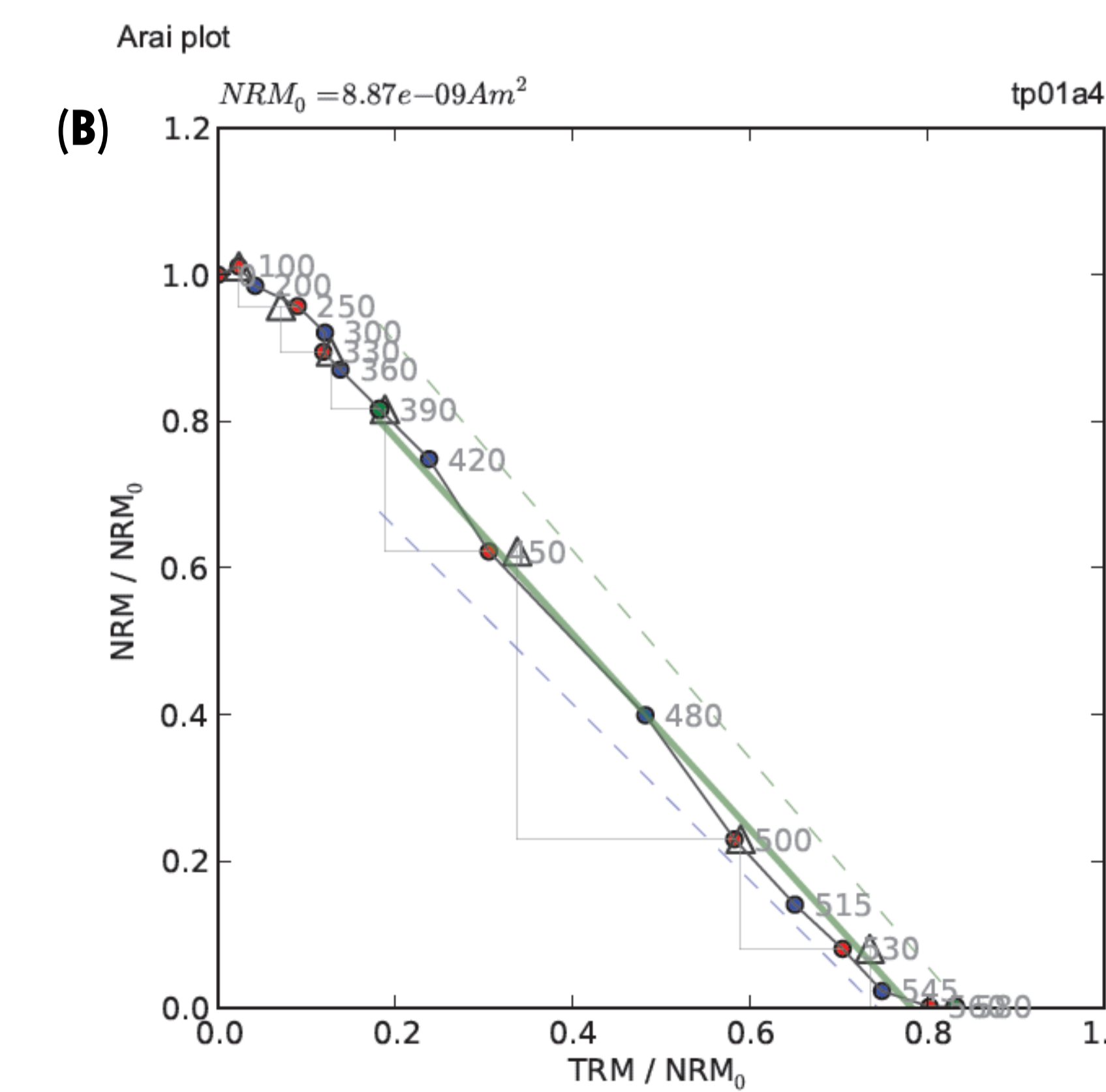
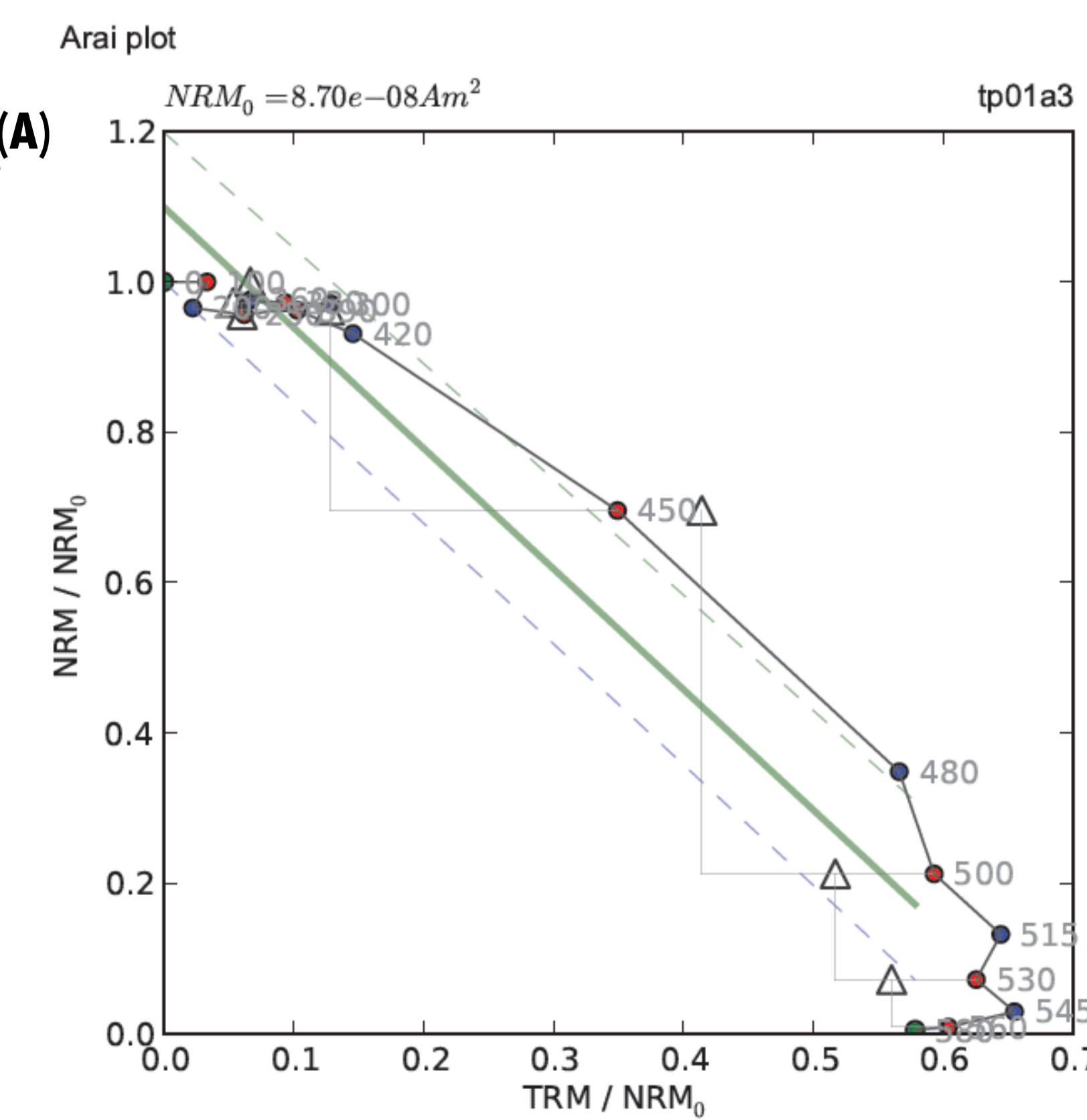


| Sample Name | Context | Number of Specimens per Sample | VAD M | Sigma VADM | Sigma Percent |
|-------------|------------|--------------------------------|-------|------------|---------------|
| tp01a | TS34, SM1 | 3 | 104.5 | 0.19 | 0.18 |
| tp02a | TS34, SM2 | 2 | 109.9 | 12.30 | 11.19 |
| tp03b | TS34, SM3 | 2 | 187.2 | 31.04 | 16.58 |
| tp04a | TS34, SM4 | 5 | 135.1 | 16.40 | 12.14 |
| tp10a | TS34, SM10 | 2 | 130.1 | 20.85 | 16.03 |
| tp22a | TS30a, SM1 | 2 | 138.6 | 13.32 | 9.61 |

Conclusions

These results show that slag mounds on the hilltop of Site 34 represent one time span while slag mounds deposited at the bottom of the hill are from different periods. The intensity values of the slag from the hilltop correspond to the early Iron Age, similar to values previously obtained from Site 30. Furthermore, new results from nearby Site 30a corroborate Rothenberg's assertion of simultaneity of production with Site 30, giving further support to the claim of intense smelting in the central Timna Valley during the early Iron Age (11th – 10th centuries BCE).

(A) and (B) Both specimens shown here are from the same piece of slag ('sample'). However, the one on the left (a) did not pass quality selection criteria (visually this is represented as the dots not being aligned in a straight line, and the triangles are far from any dots). The one on the right (b) was a good specimen that passed all criteria and therefore can be used to determine the ancient geomagnetic field at the time of cooling.



(C) Three specimen from the same piece of slag are compared to certify the results are reproducible and calculate the average VADM.