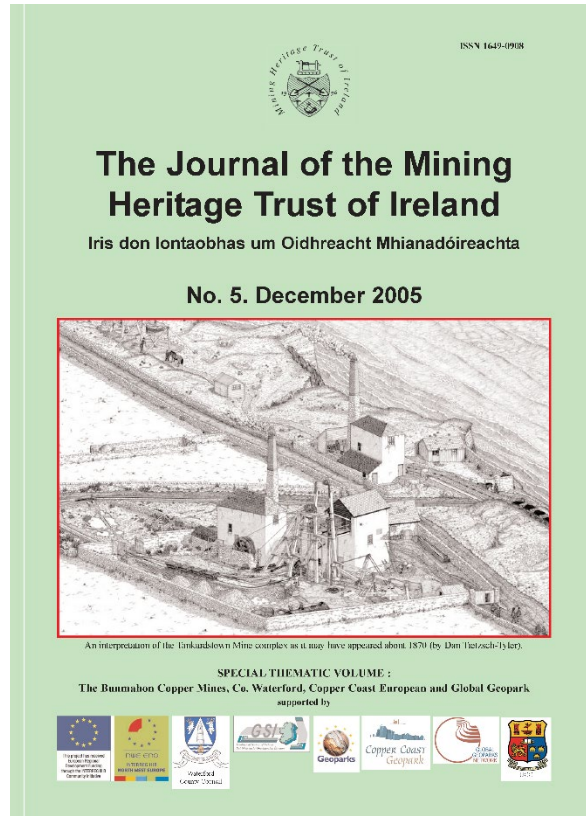


Barton, K. (2005) 'Topographical and Geophysical Surveys at Tankardstown Mine, Bunmahon, County Waterford' *Journal of the Mining Heritage Trust of Ireland,* **5***,* pp. 15-22

TOPOGRAPHICAL AND GEOPHYSICAL SURVEYS AT TANKARDSTOWN MINE, BUNMAHON, COUNTY WATERFORD

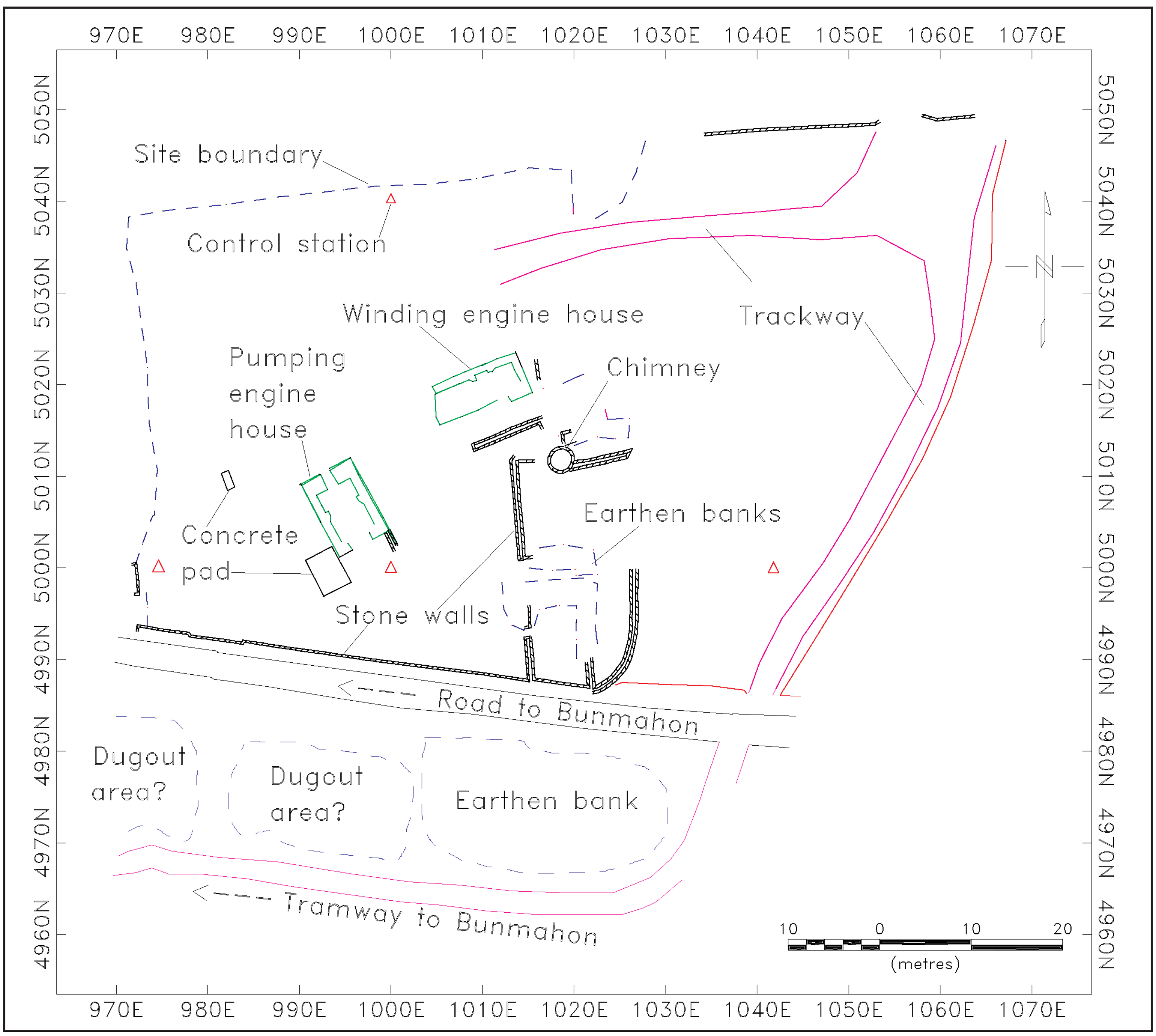
By Kevin Barton

Abstract: The results from a programme of topographical and geophysical surveys at Tankardstown Mine are presented and discussed. Recommendations are made in relation to integration of the work with ongoing research and refinement and publication of topographical and geophysical surveys at similar sites in Ireland. *Journal of the Mining Heritage Trust of Ireland*, **5,** 2005, 15-22.

INTRODUCTION

A series of topographical and geophysical surveys were carried out in the period 2000 to 2004. This work complements a survey of the underground workings (Critchley, 2002), ongoing documentary research (Coffey *et al*., 2003) and excavation (Hurley, this volume). The main objective of this work was to map the major visible site elements, there being no detailed site plan available, and to identify any sub-surface objects and features and functional areas which might provide targets for later excavation. A secondary objective was to investigate the effectiveness of geophysical techniques on this type of site, there apparently being no published material available for an Irish

Figure 1. Outline map of Tankardstown Mine showing the visible major site elements and survey control stations.



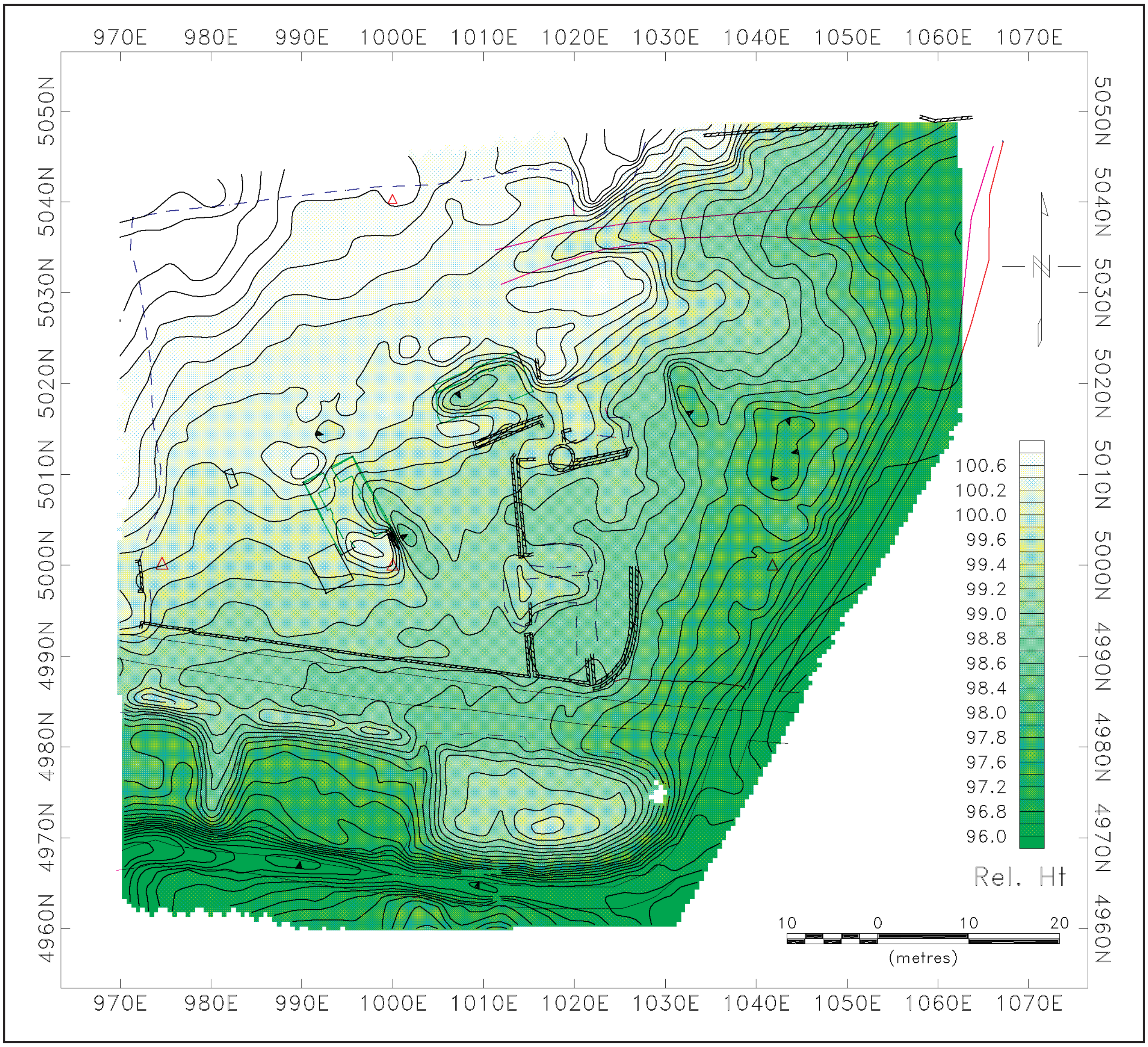


Figure 2. Coloured topographic contour map of Tankardstown Mine. Contour interval 0.2m.

site. The geophysical surveys were carried out under detection licence 00R022 issued to the author by *Dúchas - The Heritage Service* (now The National Monuments Service, Department of the Environment, Heritage and Local Government). The western portion of the site at time of survey was generally accessible with light vegetation whilst the area to the east was heavily overgrown with tall grasses and scrub.

SITE SURVEY

This work was carried out using a total station and initially involved setting up control stations and a local survey grid which was aligned with magnetic north. The grid origin at 1000E, 5000N was located near the southeast corner of the pumping engine house. The site survey enabled a simple map of the visible major site elements to be made and this is shown in Figure 1.

The main visible features of the site are the upstanding remains of the pumping engine house, the winding engine house, a chimney and remnants of various stone walls, earthen banks and concrete pads. There is no visible indication of the shaft, except for a number of piles of rubble/spoil which overlie its likely location, nor of the boiler houses used to generate steam for the engines. A trackway runs inside the east and northeast site boundary. The road from Annestown to Bunmahon runs immediately outside the southern site boundary wall with the relict tramway to Bunmahon running further to the south and cut into the top of a sheer cliff.

Between the road and the tramway lie a series of earthen features. The two western features appear to be dugout whilst the eastern one is a bank. The tramway is routed to the east of the bank and turns northwards in the direction of the trackway which forms part of the eastern boundary of the main site.

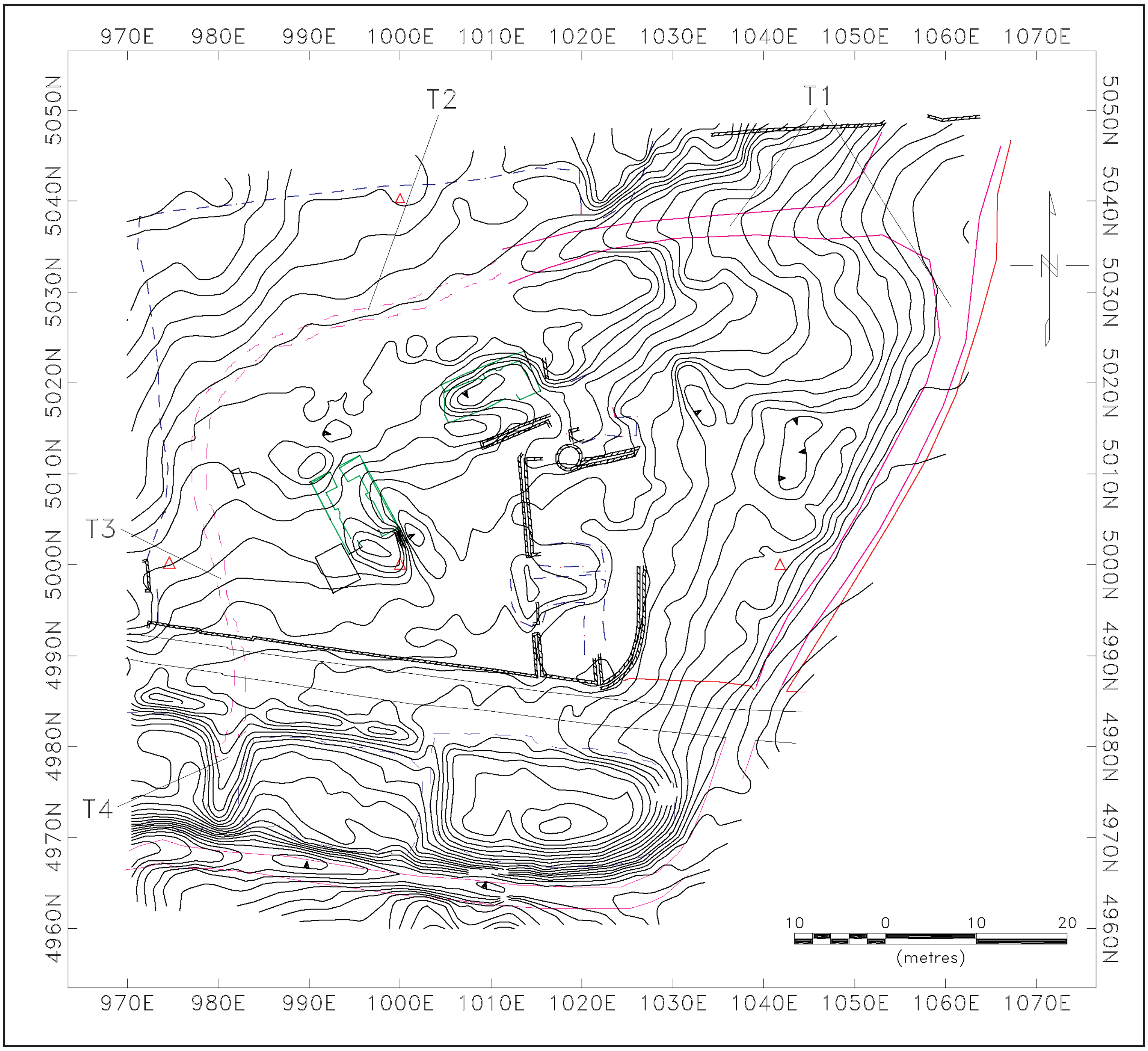


Figure 3. Outline topographic contour map of Tankardstown Mine showing a possible location for the mine tramway.

TOPOGRAPHICAL SURVEY

This survey was carried out to investigate the topographic gradients on the site which might relate to the method for delivering the ore from the shaft to the Bunmahon tramway. The survey was carried out using a Sokkia Set 500 total station and Sokkia SDR33 electronic notebook with readings taken on an approximate 2m x 2m grid. The heights are relative to an arbitrary datum of 100m at Control Station 1 located at the grid origin of 1000E, 5000N.

The height data were computer-processed to produce a series of maps and images. Figure 2 is a map with contours at 0.2m intervals. There is a height variation of nearly 5m across the site from the tramway in the south to highest point in the northwest corner of the site. The highest gradient is associated with the tramway cutting to the south whilst the gradient is consistently low to the northwest of the pumping and winding engine houses.

A possible route for the tramway carrying supplies on to the mine site and delivery method for the ore to the Bunmahon tramway is illustrated in Figure 3. T1 is the continuation on to the mine site, along the mapped trackway, of the tramway from Bunmahon. The tramway extends westwards on level ground from the end of the trackway along T2 which passes to the northwest of the pumping engine house and the shaft. Near the western site boundary the contours turn and fall in height to the south and the tramway (T3) now turns south to exit the site through a gap in the stone boundary wall. This mine tramway terminates on a narrow embankment (T4) which overlooks the cutting in which the Bunmahon tramway runs. There was likely some form of ore-chute on the embankment which allowed the ore to be tipped into the trams which took the ore to the dressing floors in Bunmahon. There may also have been a con-

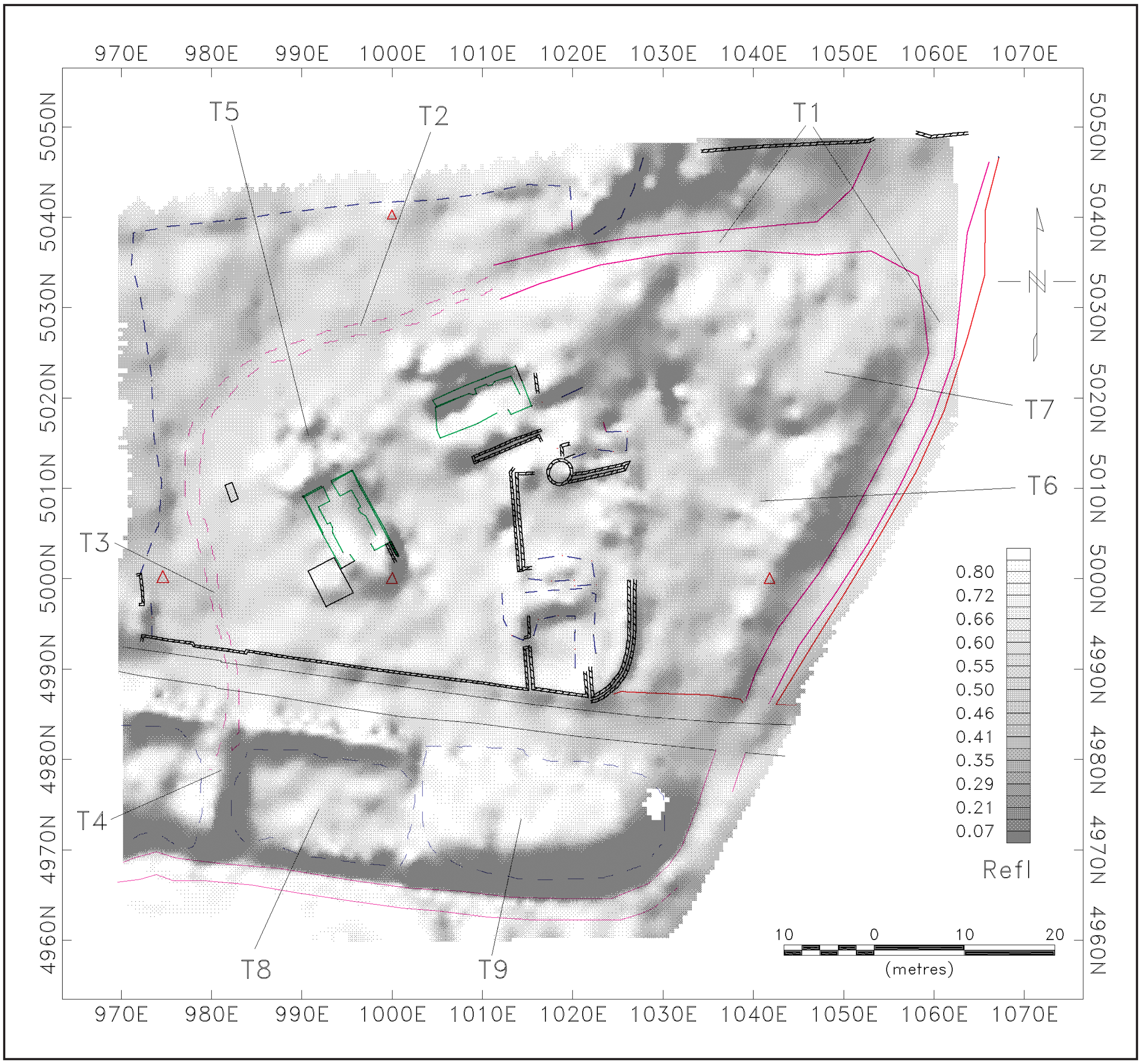


Figure 4. Interpreted greyscale shaded relief topographic image of Tankardstown Mine. Illuminated from the northwest at forty five degrees above the horizon.

tinuation of the tramway across a bridge over the cutting thus facilitating the dumping of mine waste over the cliff.

A final product derived from the digital topographic data is a shaded relief map. The shaded relief technique allows an image of the data to be created which simulates sunlight being shone on the survey area from a specified direction and at a specified angle above the horizon. The technique can identify subtle features not easily recognised from a standard contour map.

Figure 4 is a shaded relief map illuminated from the northwest at forty five degrees above the horizon. T1 to T3 illustrate the postulated route of the mine tramway and the embankment T4 whilst T5 indicates the likely location of the shaft which is overlain by rubble/spoil. The area to the east of the main site was heavily overgrown and it was difficult to survey. T6 may be a remnant wall or bank. Feature T7 is a pronounced rise in topography, which may be natural, possibly indicating the area surrounding T6 may have been cut away or, if it is not natural, it may be spoil from excavating the trackway/tramway T1 (see also Figure 2). T8 clearly indicates one of the possible dugout areas to the south of the Bunmahon road. It may be that this, and the similar area to the west, provided the material to construct and maintain embankment T4. If the interpretation of T8 is correct, then the bank T9 is likely to be a natural feature.

GEOPHYSICAL SURVEYS

Magnetic susceptibility survey

This reconnaissance survey was carried out to map likely areas of slag, ash or other burnt material which might indicate functional areas of the site such as a blacksmith's shop, boiler houses and ore or waste dumps.

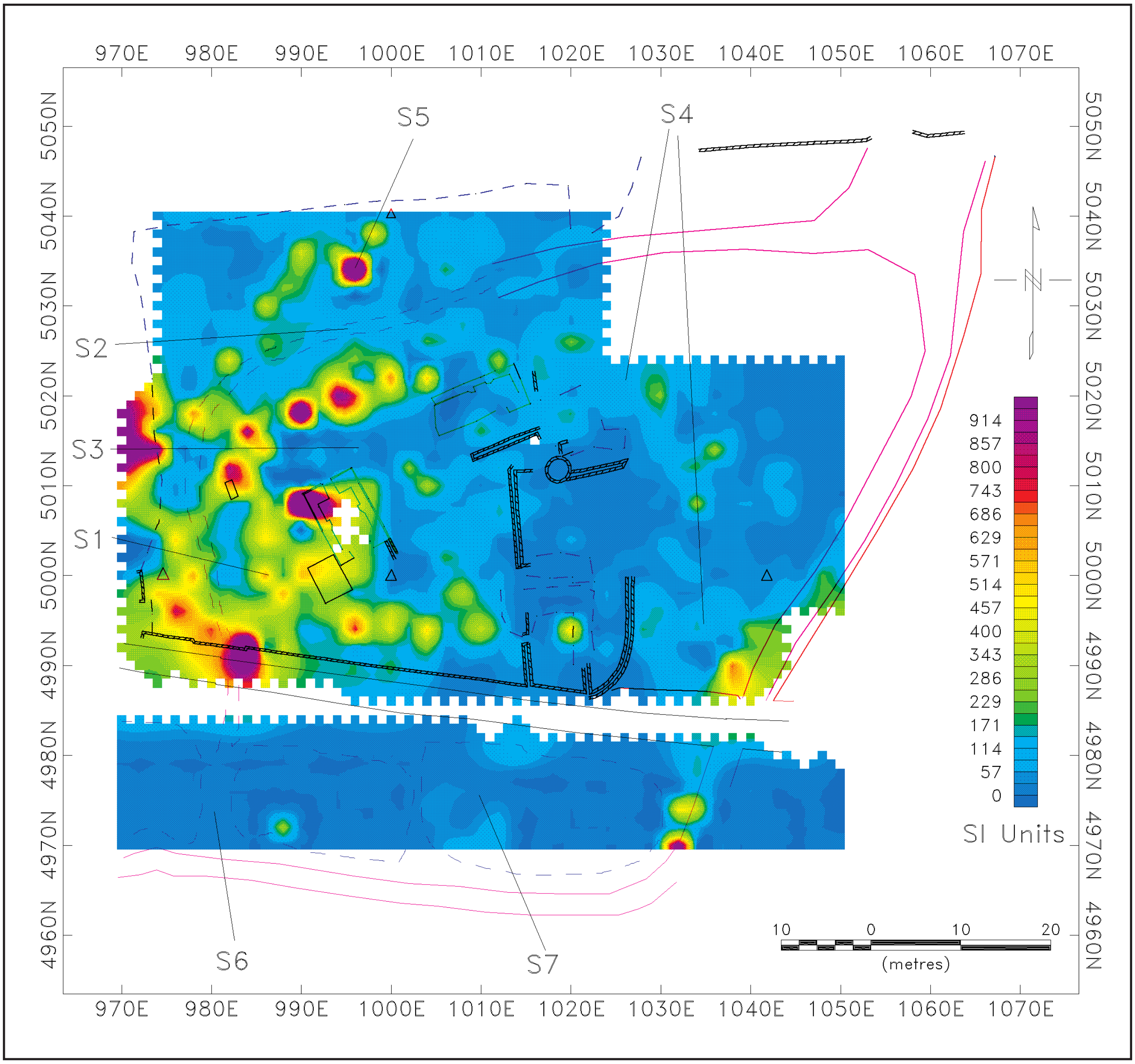


Figure 5. Interpreted coloured image of the results from the magnetic susceptibility survey of Tankardstown Mine. Data range 0 to 1000 x 10^{-5} SI units.

The magnetic susceptibility of materials such as soils and archaeological sediments is a measure of the ability of these materials to be magnetised. This ability is affected by the presence and amount of ferrous iron minerals or oxides and whether these minerals have been burnt thereby enhancing their magnetic susceptibility (Clark, 1996; Gaffney & Gater, 2003). Volume specific magnetic susceptibility measurements were carried out on a 2m x 2m grid using a Bartington MS2 magnetic susceptibility meter and MS2D 18cm diameter fieldloop. The effective depth of investigation using this equipment is approximately 0.1m which means the measurement is largely the magnetic susceptibility of the topsoil.

The field data were computer-processed to produce coloured grids or images showing the variability of magnetic susceptibility in the topsoil. Exceptionally high values of magnetic susceptibility were measured with values reaching nearly 2900 x 10^{-5} SI units. These high values dominated the bulk of lower values measured and, in order to produce interpretable maps, the data were clipped to remove the high values. Figure 5 shows the magnetic susceptibility data clipped to show the data in the range 0 to 1000 x 10^{-5} SI units.

There is a pronounced zonation of high values in the southwest corner of the mine site indicating that this was a significant area of mine activity. Within this area there are a number of isolated high spots (e.g. S1) which may relate to hearths or ferrous metal objects. Feature S2 shows a curvilinear zone of relative low values which correlates with the projected line of the tramway. A second, more linear zone (S3), of relative low values lies to the south of S2; this could be mapping out the route

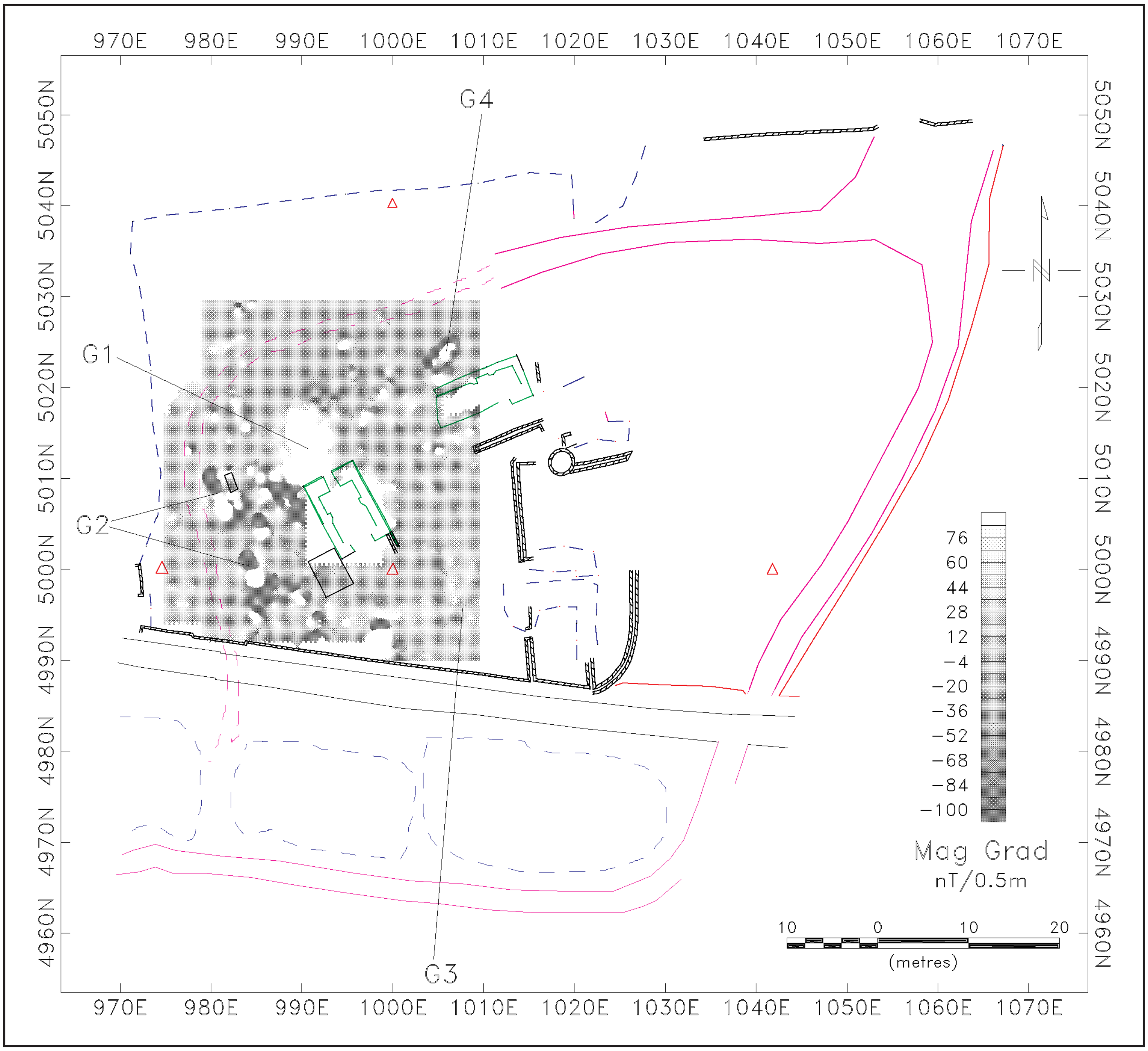


Figure 6. Interpreted greyscale image of the results from the magnetic gradiometry survey of Tankardstown Mine. Data range + 100 to -100 nT/0.5m

where a ropeway ran from the winding engine house to the headworks above the shaft. S4 denotes two arcuate relative low zones with values of the order of 100 to 150 x 10^{-5} SI units. These could be delimiting the easterly activity zone on the site. To the west of these zones lies an area of low values which are located between two stone walls. This may indicate a non-industrial usage such as offices or stores. There are a number of isolated high values (S5) which could be due to hearths, iron objects or boulders with significant content of iron oxides. The area to the south of the Bunmahon road has low values (S6 & S7), especially in the vicinity of the embankment (Figure 4, T4), where high values due to ore loading would be expected. Here it may be that the area has been cleared and reinstated subsequent to the closure of the mine.

Magnetic gradiometer survey

This detailed survey was carried out to map features such as buried walls and ditches and ferrous objects. The technique measures the vertical magnetic gradient which largely varies with the degree of magnetic susceptibility of surface and sub-surface materials (Clark, 1996; Gaffney and Gater, 2003). Measurements were made on a 0.5m x 0.5m grid using a Geoscan Research FM36 fluxgate instrument. The fluxgate sensors are set 0.5m vertically apart. The depth of investigation was approximately 1m.

The field data were computer-processed to produce greyscale grids or images showing the variation of magnetic gradient within the survey area. As with the magnetic susceptibility survey exceptionally high values were recorded which in this case approached positive and negative gradients of 2000 nT/0.5m. In order to produce interpretable images the data were clipped to positive and negative gradients of 100 nT/0.5m in order to remove the high values. The resulting image is shown in Figure 6.

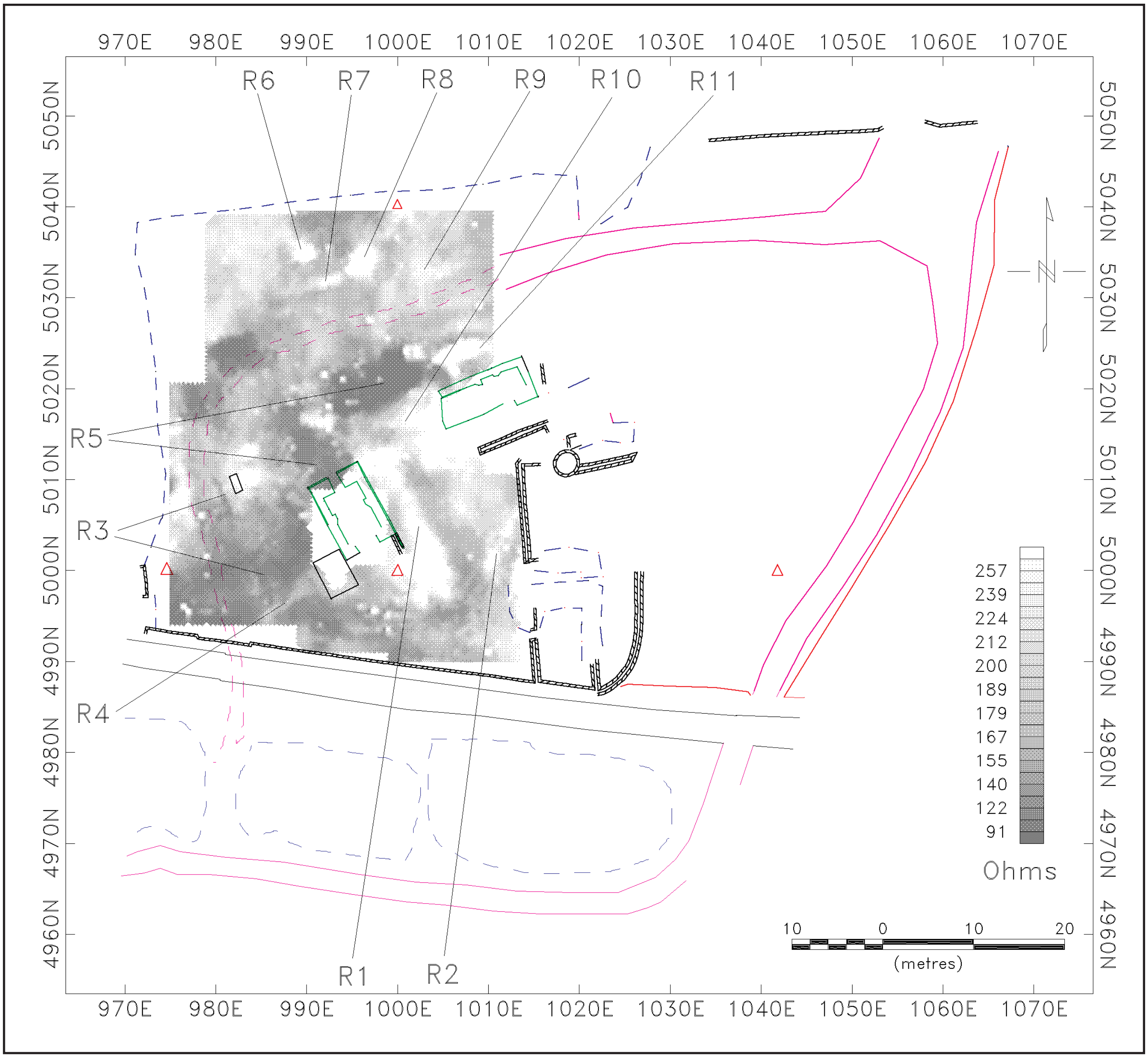


Figure 7. Interpreted greyscale image of the results from the electrical resistance survey of Tankardstown Mine.

The overall texture of the image indicates a random scatter of features which include iron objects, pits and buried masonry. The area immediately to the northwest of the pumping engine house is dominated by very high positive gradient (G1). This area corresponds to the shaft opening. The high positive values are undoubtedly due to the disposal of a burning lorry down the shaft during the filming of the motion picture "The McKenzie Break" which was released in 1970. There are two strong dipolar features (G2) which are likely to be caused by individual iron objects. G3 is a narrow, arcuate feature with negative gradient. Negative gradient in most circumstances can indicate buried walls or masonry. Feature G4 has a positive gradient which may indicate an accumulation of sediment or fill. This feature is just to the north of the winding engine house and may indicate a pit filled with sediment. This could relate to a now silted pit for the winding mechanism or a capstan.

Electrical resistance survey

This detailed survey was carried out to map buried features such as stone or masonry foundations and pits and complements the magnetic gradiometry survey.

The technique largely responds to soil permeability and the degree of retained soil moisture whereby low permeability and low moisture conditions will result in higher electrical resistance being measured in comparison to high permeability and high moisture content which results in lower resistance being measured. Generally high resistance indicates sub-surface walls or masonry or areas of compaction, cobbling etc and low resistance can be interpreted to be due to buried or silted ditches or pits. In some cases buried, compacted, less permeable features such as earthen floors and areas of cobbling can cause moisture to reside, or perch, in sediments lying on them and result in low resistances being measured. The survey was carried out on a 0.5m x 0.5m grid using a TRS/CIA electrical resistance meter with a 0.5m twinprobe array. The approximate depth of investigation was 0.5m.

The field data were computer-processed to produce greyscale grids or images showing the variation of electrical resistance within the survey area. The overall impression gained from the image is of discrete areas of high and low resistance forming, in most places, a coherent and interpretable pattern. R1 is an area of high resistance running along the eastern edge of the pumping engine house and undoubtedly maps the outline of the boiler house. R2 is a high resistance linear feature which is running in the direction of the chimney. The feature is in the same general position as G3 seen in the magnetic gradiometry data (Figure 6). This feature, from excavation, is the stone-lined flue from the engine house. At the western side of the site R3 denotes a number of narrow, low resistance linear features which are ditches or drains. R4 is a moderately high resistance linear feature which appears connected to the concrete pad at the southwest corner of the pumping engine house. This might be a path or area of compacted/cobbled ground. R5 indicates two rectilinear areas of low resistance. The first area is immediately in front of the pumping engine house and may relate to a large back-filled area incorporating the shaft. The second area lies to the northwest of the winding engine house and may relate either to an area of compacted ground with perched moisture above or a back-filled pit related to the winding mechanism. R6, R7, R8 and R9 are a combination of linear and rectilinear high resistance features which might be a combination of building foundations, internal floors or retaining walls. R10 marks a general area of high resistance, which from excavation, is a cobbled area. R11 is an area of high resistance which correlates with G4 seen in the magnetic gradiometry data (Figure 6). The high resistance could be caused by partially compacted fill in a pit.

CONCLUSIONS AND RECOMMENDATIONS

The programme of topographical and geophysical survey has contributed to a better understanding of the surface/sub-surface features and functioning of the mine site. The topographic survey has provided some indications of the possible means of ore delivery to the Bunmahon tramway and the disposal of mine waste. From the magnetic susceptibility survey the main activity and ore handling area seems to be in the southwest corner of the site which corresponds with the indications from the topographic survey. The location of a number discrete iron objects was identified from the magnetic gradiometry survey. The precise location of the shaft was not possible due to the swamping of the gradiometry data caused by the dumping of a lorry down the shaft. The electrical resistance survey contributed more coherent features which could be interpreted in terms of now buried mine infrastructure and building layout.

Each technique deployed contributed information about the site and future surveys on sites of this type should also adopt this strategy. There is a need to further integrate the results of the topographical and geophysical surveys with the results of ongoing documentary research and the findings from the recent excavation at Tankardstown. Geophysical techniques for research and commercial purposes are now becoming more commonly used on pre-historic and historic archaeological sites in Ireland (Barton, 2003; Barton & Fenwick, 2005). Further work is needed to refine and subsequently publish the results from topographical and geophysical surveys on eighteenth and nineteenth century mining sites in Ireland.

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ACKNOWLEDGEMENTS

This work was carried out whilst the author was in the Applied Geophysics Unit, National University of Ireland, Galway (NUIG) and latterly with Landscape & Geophysical Services (LGS) in Claremorris, Co Mayo. Many people have contributed their time both in facilitating and carrying out the work including Colin Brown, Louise Geraghty and Shane Rooney (NUIG); Donna Damianoff and Nadine Ivers (LGS); Martin Critchley, Des Cowman and John Morris (MHTI) and Karen Többe of the Copper Coast Geopark.