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THE EXTENT OF BELLAND GROUND ADJACENT TO TIDESLOW AND MAIDEN RAKES - LITTLE HUCKLOW

by J.M. Bayliss, P.R. Ineson and I.H. Rorison

Summary

As part of a geobotanical project investigating the relationship between mineralisation and contaminated soil-herbage at Tideslow Farm, a geochemical survey was conducted across the area. The investigation has indicated a wide spread of enhanced lead, zinc and copper values in the soils adjacent to the mineral veins. It shows that the toxic ground adjacent to veins is more widespread than had been previously supposed. Possible reasons for the widespread dispersion of these trace elements include levelling out by ploughing, the passage of hoofed animals, weathering and transportation processes. Walls bounding mineral workings are shown not to be a reliable guide to the limits of belland ground.

Situated on the Carboniferous Limestone, with several mineral veins, Tideslow Farm, as with other farms in Derbyshire, has been known to contain "belland" ground now known to be due to the presence of toxic concentration of minerals. This has given rise to apparent lead poisoning in a number of animals. As a common farming practice the owners or tenants have been forced to restrict the grazing of animals during some times of the year, particularly at lambing time, over such ground. It has often been the case that the local inhabitants have only considered the ground to be "belland" if visual signs of past mining activity were present. More recently local veterinary practitioners have revealed clinical lead poisoning in animals, which have not known to be grazing over ground with visible evidence of past mining. With such information at hand, it was decided to investigate the trace element constituents in the soils of Tideslow Farm.

PREVIOUS RESEARCH

Blaxter and Allcroft (1950) and Allcroft (1951) have indicated the effect of lead poisoning in cattle and sheep, while Alloway (1973) reported the effects of copper and molybdenum in sway-back pastures. With respect to the southern Pennine area in general, although a considerable amount of veterinary information is available, as yet little has been published.

A number of geochemical surveys have reported enhanced trace element values in the bedrocks, soils and waters. Ineson (1970) reported enhanced trace element aureoles in limestone wallrocks adjacent to mineralisation in the Eyam area. A dispersion aureole, in the bedrock, extended out to a distance of 15 m where Pb, Zn, Cu and F were enhanced. Nichol *et al.* (1970) from a regional stream sediment geochemical reconnaissance survey indicated anomalous values related to mining and smelting activity. So also did Edmunds (1971) in a hydrogeochemical survey of the region. On a more localised scale enhanced Pb-Zn values in soils and waters of the Castleton area were revealed during student exercises in geochemistry. They proposed that the anomalies were related to a continuation at depth of Odin Vein. Ineson and Al-Kufaishi (1970) likewise reported soil borne leakage dispersion aureoles related to Long Rake Vein in the vicinity of Rowsley. In this case, enhanced Pb-Zn values were detected in soils at a distance of 2500 m from the known outcrop of the mineralised fault.

GEOLOGY AND MINERALISATION AT TIDESLOW FARM

A geological sketch map, modified slightly from the 1:25,000 Institution of Geological Sciences Sheet SK 18 (Edale and Castleton) is shown in fig. 1. The farm is bordered on the south by Tideslow Rake, while to the north is Maiden Rake. Fig. 1 also illustrates a number of minor veins aligned subparallel to the major rake veins. These are not so evident on the ground nor from aerial photographs. An explanation is possibly due to ploughing which has levelled the adjacent ground, and re-seeding at infrequent intervals.

Mineralogically the rakes and veins which intersect the area are predominantly calcitic with varying amounts of galena, baryte, fluorite, chalcopyrite and sphalerite. A proportion of secondary alteration minerals are present of which cerussite is the most predominant.

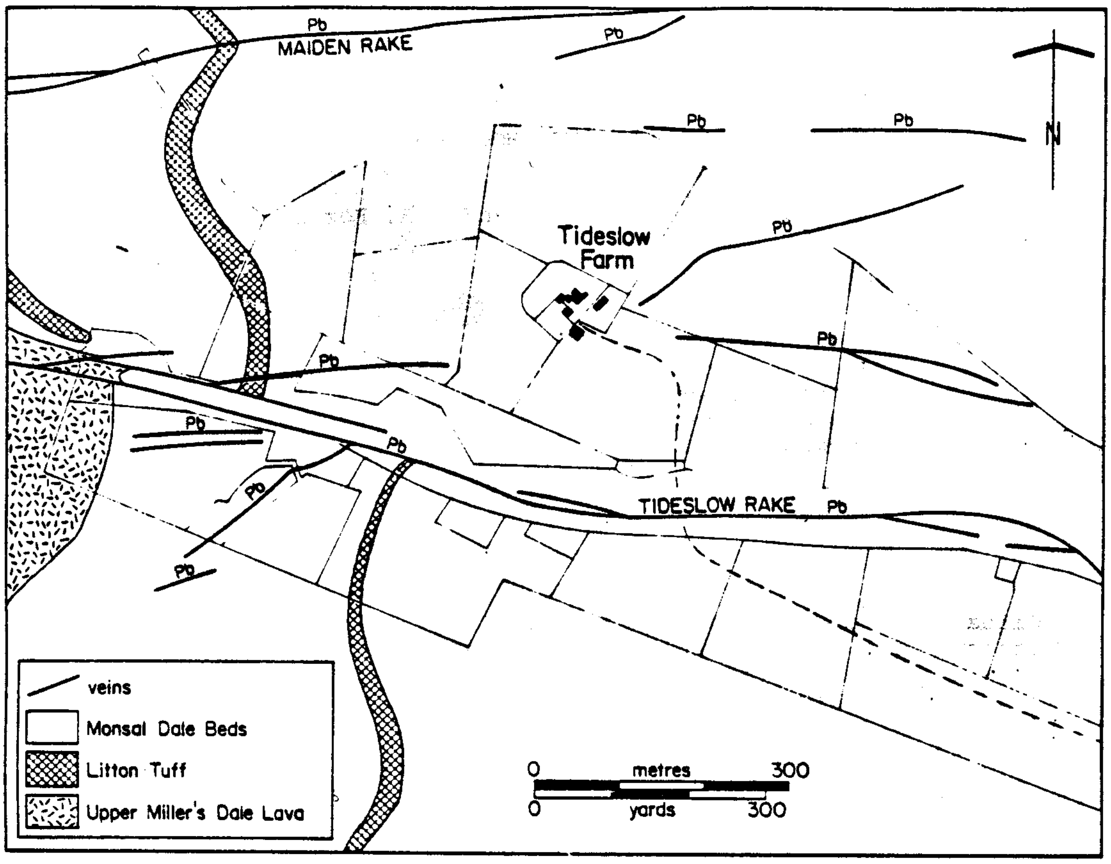


Fig. 1. Geology and mineral veins of Tideslow Farm.

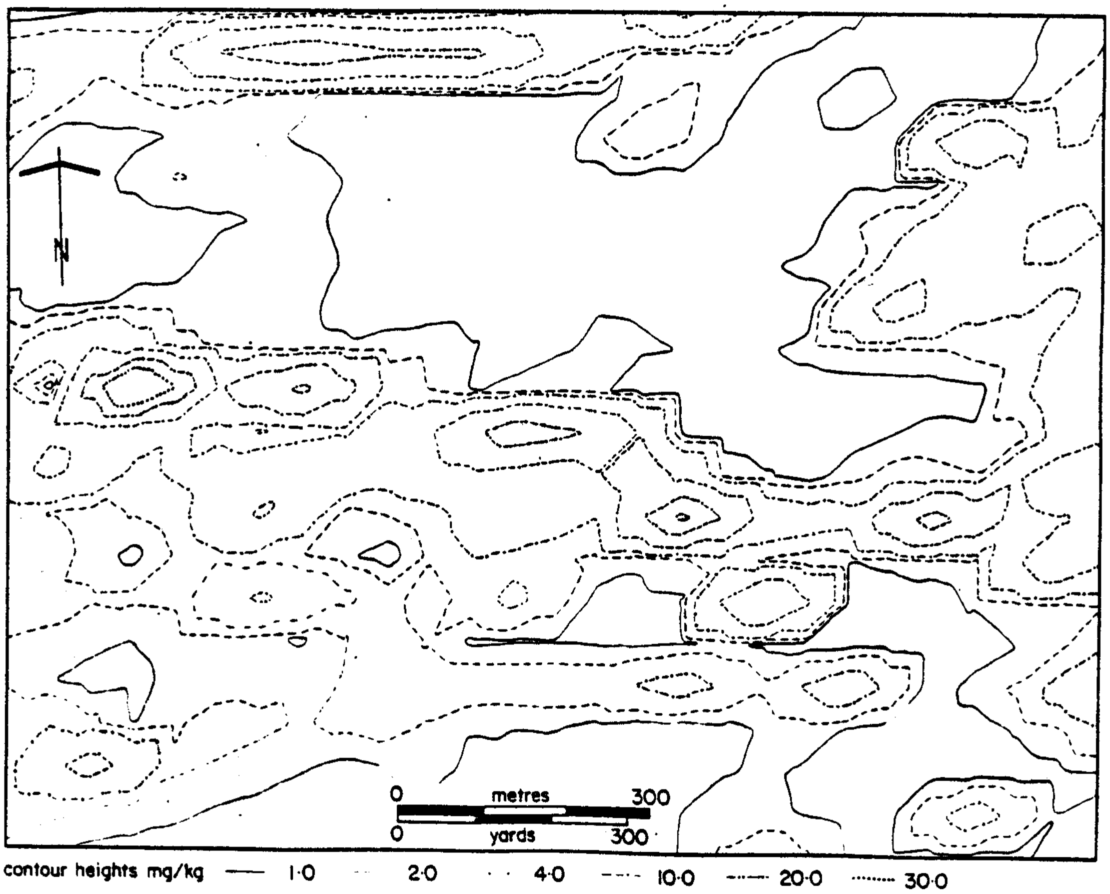
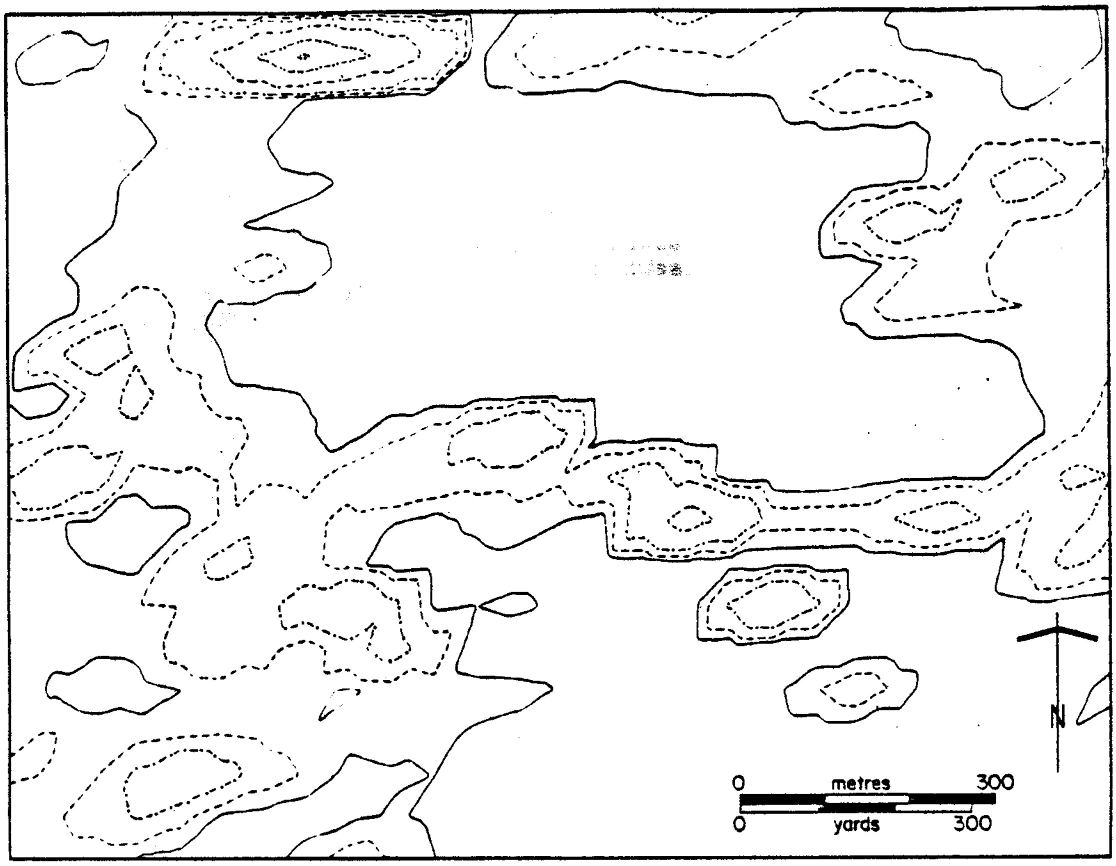
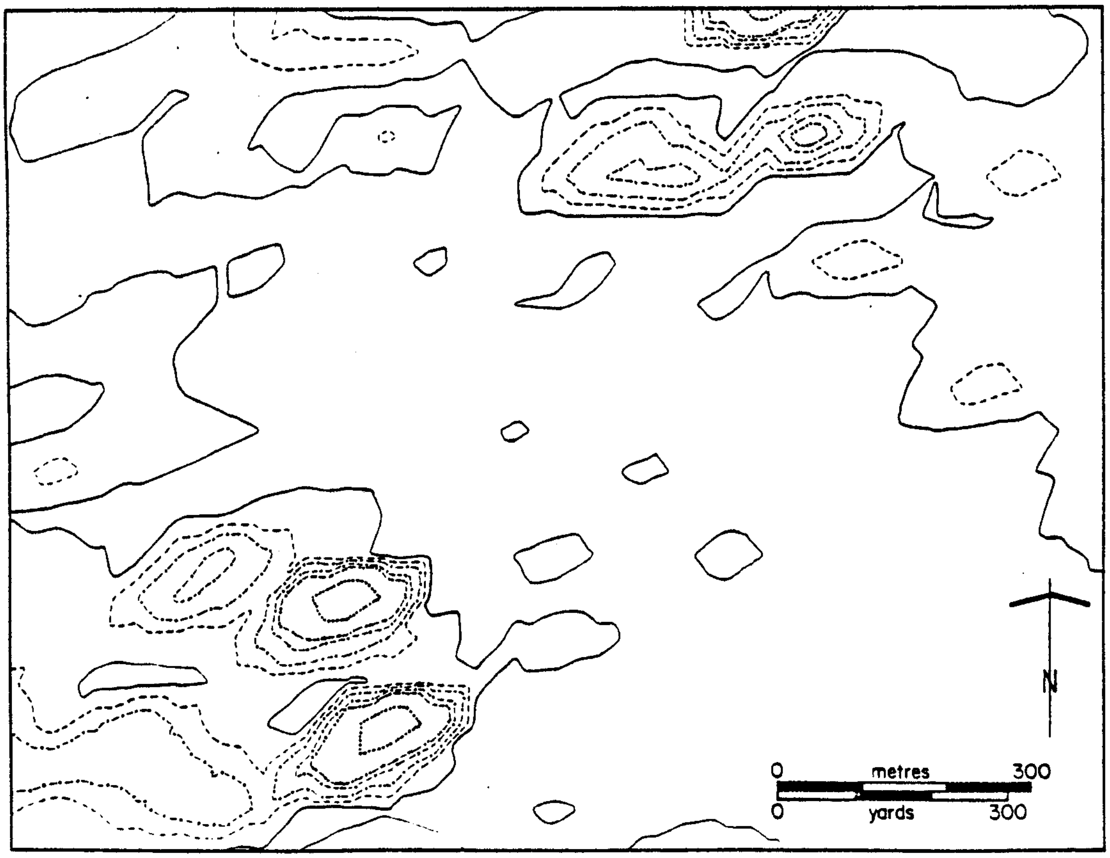


Fig. 2. A water-soluble lead geochemical map of Tideslow Farm, redrawn from a three-colour graphical output from an ICL 1906S computer.



contour heights mg/kg —— 1·0 - - - 2·0 -·-·- 4·0 --·· 10·0 ---·· 20·0 ······· 30·0

Fig. 3. A water-soluble zinc geochemical map of Tideslow Farm.



contour heights mg/kg —— 0·1 - - - 0·3 ····· 0·5 --·· 0·8 ---·· 1·0 ······· 2·0

Fig. 4. A water-soluble copper geochemical map of Tideslow Farm.

GEOCHEMICAL SURVEY AND ANALYSES

The farm covers an area of 63.13 hectares (156 acres). It was decided to overlay a 100 m square grid and sample at each corner and the centre point of each square. This resulted in the collection of 300 samples. The material ideally should have been collected from the same soil horizon. This, however, proved to be impractical as the thin veneer of soil varied in depth from 0.05 to 0.12 m. Wherever possible samples were collected within maximum root development. Standard sampling, storage and preparation techniques were employed prior to analysis. The trace metal content of different grasses and other herbage, while obviously significant, forms the subject of a further study which will be reported elsewhere.

A Pye-Unicam atomic absorption spectrophotometer (model SP190) was used for the determination of Pb, Zn and Cu. As a check on the accuracy of the analyses, replicate analyses were performed on laboratory manufactured artificial standard covering the range 1 - 5 ppm. Where values greater than these were found, standard dilution techniques were used to cover ranges up to 40 ppm.

RESULTS

The University of Sheffield's ICL 1906S computer was used to generate the geochemical maps for lead (fig. 2), zinc (fig. 3), and copper (fig. 4). A graph plotter package (GHOST) developed by the Culham Laboratories of the U.K.A.E.A. was used.

As this survey forms part of a larger project, in which the uptake of elements in specific grass species was investigated, the results report the varying concentrations of the water-soluble fraction of Pb, Zn & Cu respectively.

Fig. 2 indicates the geographical distribution of water-soluble lead in the area. As may be seen, this of all the three elements more closely indicates the position of the mineralised ground. However, although values greater than 20 ppm Pb occur in the soils directly overlying the veins, values in excess of 10 ppm are located at distances of 30 m from known veins.

The distribution of water-soluble zinc in the area (see fig. 3) likewise illustrates a range in concentration from less than 1 ppm to more than 20 ppm. It does not, however, sympathetically parallel the anomalous values for lead. This is no doubt due to its relatively enhanced mobility with respect to lead (see Hawkes and Webb, 1962). Of the three elements reported in this paper, with respect to the theoretical geochemical mobility, copper might be expected to show the most widespread and hence diffuse variations from the local background values. This is not found to be the case (fig. 4). Values in excess of 0.3 ppm occur directly over the rakes and veins. Localised but enhanced concentrations (up to and greater than 2 ppm) are located in the south-west and north-east areas of the survey. The former locality may be related to downslope migration of soluble copper being leached out of the Litton Tuff. The northerly anomalous areas most probably related to discrete concentrations associated with Maiden Rake and its attendant veins and scrins.

In consideration of the known water-soluble compounds associated with the local mineralisation (Ford and Sargeant, 1964) as well as the theoretical concentration levels, the values reported from this area appear to be relatively enhanced. An explanation may be due to the fact that natural mineral stability has not been the case in this area, due to the frequent application of artificial fertilisers as well as excessively low pH farm effluent. Liming the fields does occur, but from routine checks on pH levels, the effects do not last as long as was to be expected. A pH level of 7 diminished to that of 5.5 within thirty days, no doubt partly due to the high precipitation recorded in this upland region of the Pennines.

CONCLUSIONS

The geochemical survey has indicated the relative abundance of the three elements - Pb, Zn and Cu, adjacent to old mineral operations. A point to note, and one which is considered significant, is that this area represents one of the few remaining localities in Derbyshire where recent tributor mining operations have not reworked the old lead miners' spoil heaps.

If the latter had been the case, then the widespread and enhanced anomalies might be attributable to reworking and redistribution of ancient mineral working spoil. This, it is proposed, is not the case in the ground surrounding Tideslow and Maiden Rake, possibly because of the low (<30%) fluorspar content of the spoil heaps.

The widespread distribution of the three elements cannot likewise be directly related to surface or sub-surface groundwaters. If this was the case, and considering the predominant easterly dipping ground surface, it would be expected that dissolution and migration would be subparallel and to the east of the known veins.

Prior to the survey being conducted it was assumed that the extend of 'toxic ground' did not extend beyond the limits of the adjacent and deliminating field walls, some of which clearly bound the mined ground. This was found not to be the case. A number of explanations can now be proposed:

(a) Over the years, since the veins were actively exploited, the adjacent land has been ploughed, harrowed and infrequently re-seeded. This has 'levelled out' the distinctly disturbed ground which is typical of old mining spoil.

(b) Animals, especially cloven-hoofed animals, have carried the small mineral fragments on their feet over the adjacent ground.

(c) Transportation by wind or ground water movement has extended the micro-fragments and/or the water-soluble fraction of the vein and/or spoil heaps.

(d) The walls do not indicate the former extent of the 'mineral workings', which include the adjacent ground given over to dressing the ore. The walls themselves were erected by virtue of the Enclosure Acts in 1814 or soon afterwards (pers. comm., Mr. D. Fowkes of Derbyshire Records Office). The mine workings on Tideslow and Maiden Rake are certainly older than early 19th century. The walls therefore may have been erected to delimit the ground, which was then (1814 to 1820?) considered to be 'belland ground'. Other reasons for the location of the walls may be a possibility. However, as no proof is available, hypotheses are not forwarded.

It is concluded, however, that from this locality in particular, and no doubt from a large number of other areas, some of which are known to the authors, due caution should be exercised when visible or hearsay evidence is forwarded for ground being classified as 'belland'.

Interested parties, it is suggested, should consult geological/geochemical maps as well as historical evidence for mining leases and old transportation routes.

A minimal amount of energy being expended on direct or indirect research, may prove beneficial to local landowners, farmers of 'incomers' who have suffered the effects of lead poisoning in animals or who may suspect belland ground. The attendant problems associated with this accepted, but not as yet fully understood, geochemical and veterinary question may then be minimised.

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J.M. Bayliss
P.R. Ineson
I.H. Rorison

Departments of Geology and Botany,
University of Sheffield.