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Middelburg Ferrochrome – CDR Slimes Geophysical Survey Report

1. General

Ground magnetics and electromagnetic surveys were conducted over the CDR Slimes area, an old tailings storage facility (TSF) due to be de-commissioned at Middelburg Ferrochrome. The objective of these surveys was to locate any geological structures such as faults, dykes or joints which may destabilise the slimes dam area, or which may be hosting ground water movement.

2. Methodology & Statistics

The ground magnetics survey was done as a grid survey with 50m line spacing and 3.5m station spacing. The instrument used was a Gem GSM-19 Walkmag, with G857 base station for diurnal correction. The 15 lines were orientated north-south and were approximately 890m long each, thus totalling 13.4 km of magnetics. This is shown in Figure 1 below. Gaps in the survey lines were due to the presence of water in some of the paddocks.

The electromagnetic (EM) data were collected with a Geonics EM34 which comprises a transmitter loop (Tx) and a receiver loop (Rx) connected with a 40m cable. These loops can be used either horizontally or vertically in order to penetrate to different depths and couple better with either horizontal or vertical bodies. The instrument 'sees down' approximately half the Tx-Rx distance, thus being around 20m. A reading was taken every 10m along 4 lines along the outsides of the slimes dam, as shown in Figure 1.

One serious complication on site was the presence of a high-voltage Eskom power line on the east side of the dam, running very close to the path of EM line 4. Magnetics, resistivity and electromagnetic data are all affected by power lines. This effectively nullified the data on the east side, rendering Line 4 useless, and a portion of magnetics data which had to be removed from the dataset.

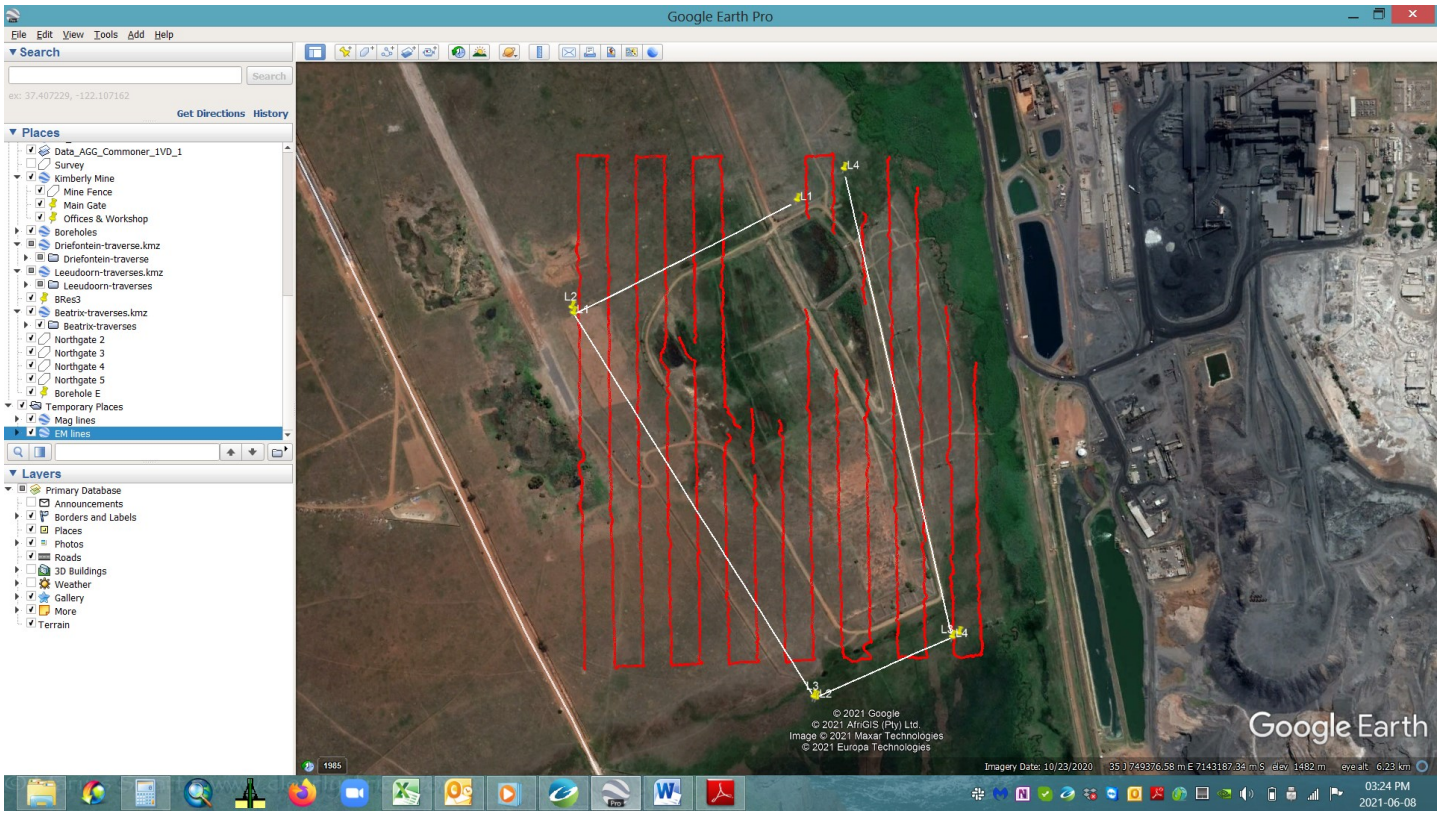

Figure 1 – Ground magnetic lines shown in red and EM lines shown in white, overlaid on satellite image of the CDR slimes area. Missing magnetics data is owing to the presence of water.

3. Results

Figure 2 below shows the magnetics results, gridded into a colour image at 12.5m cell size. The effect of the power line can clearly be seen. These data were cut out and the data then re-gridded, yielding a more useful image as shown in Figure 3.

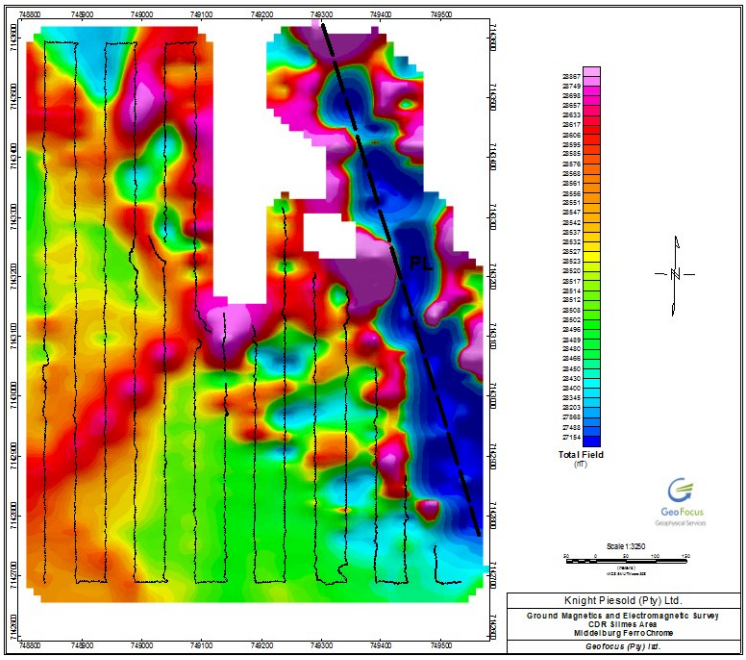

Figure 2 – Total magnetic field from the ground magnetics survey.

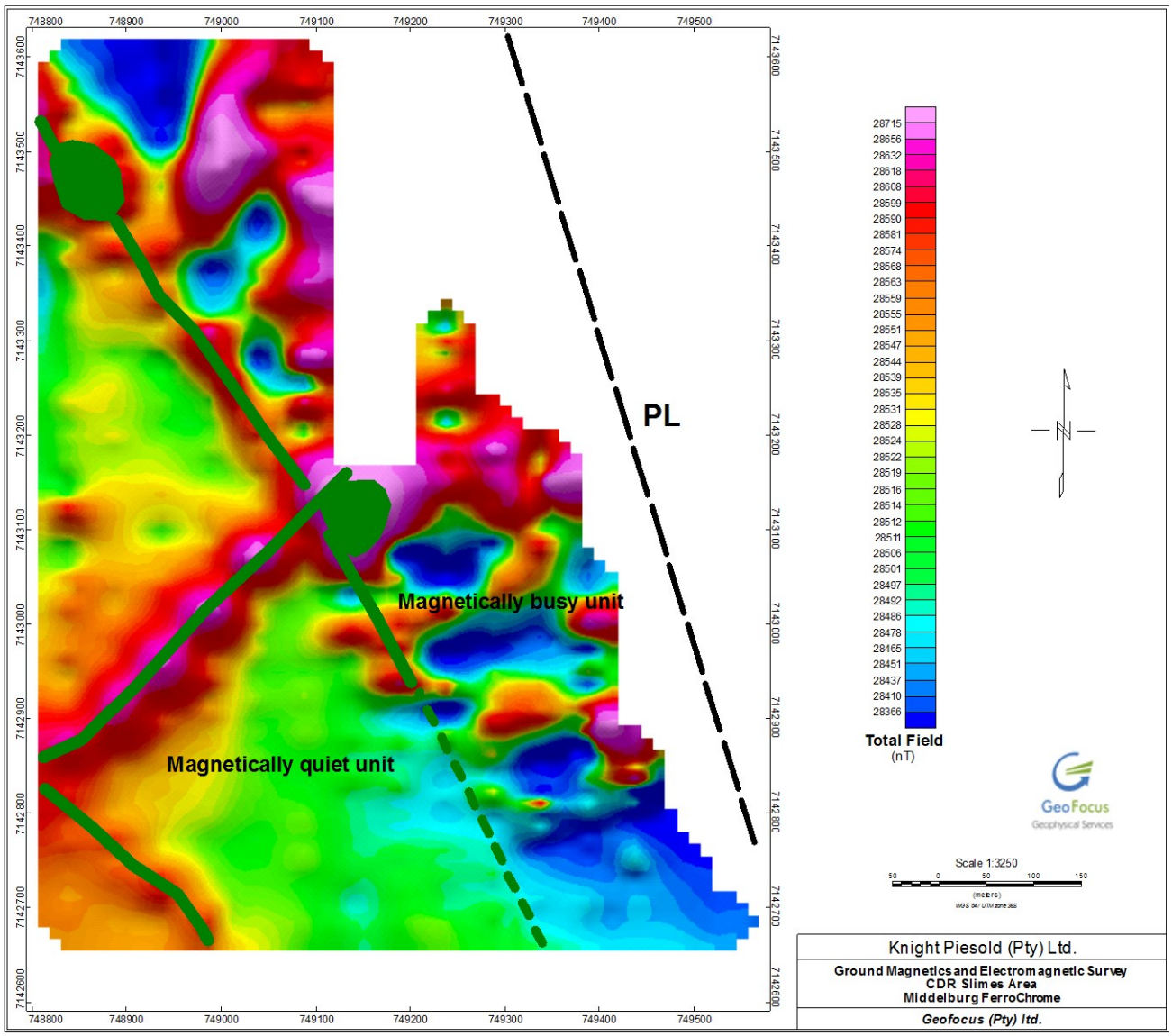

Figure 3 – Total magnetic field from the ground magnetics survey, with the bulk of the power line noise removed. Interpretation overlaid.

In Figure 3, interpreted dolerite dykes have been overlaid as thick green lines, and larger 'blows' or sills along these as sub-circular bodies. Two prominent dykes seem to intersect in the middle of the survey, where they coalesce to form a blow. The prominent NW-SE trending dyke in the centre of the survey seems to peter out to the SE but continues as a contact ,or faulted contact, marked in green dashed line. The magnetic characteristics on either side of this contact are very different, the lithological unit to the east of the dyke/contact being magnetically busy, and magnetically quiet on the west side. This structure lies on the western side of the slimes dam and should clearly be taken into account, as should the dyke trending NE through the dam. Dykes often form along faults, and can be water conduits.

When the horizontal dipole (HD) EM results for lines 1-3 are overlaid in profile, the result can be seen in Figure 4 below. Line 4's data was discarded due to the power line, and some data on Line 3 was discarded close to the power line. The data are noisy due to the power line.

The vertical dipole (VD) results are shown in Figure 5. Line 4's data was discarded due to the power line, and some data on Line 3 was discarded close to the power line. The vertical dipole data was more strongly affected by the power line than was the horizontal dipole data at close proximity. The data are again noisy due to the power line.

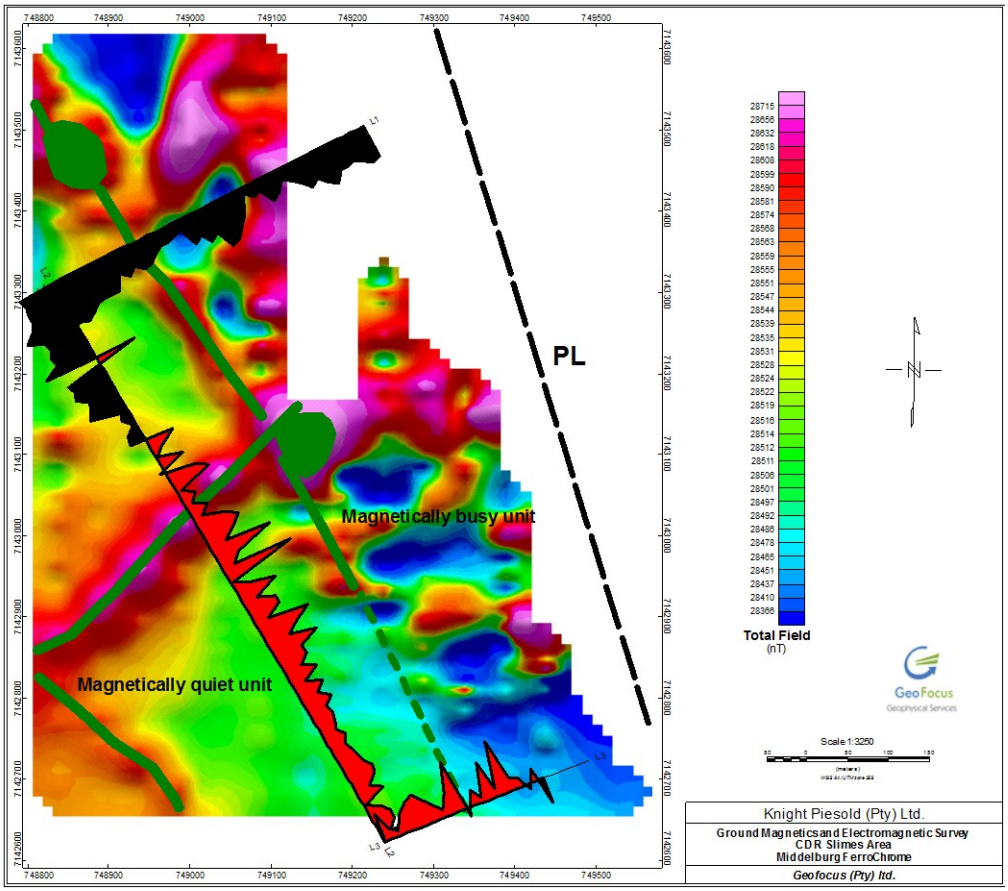

Figure 4 – Horizontal dipole EM trace shown in black. Positive values are red, negative are black.

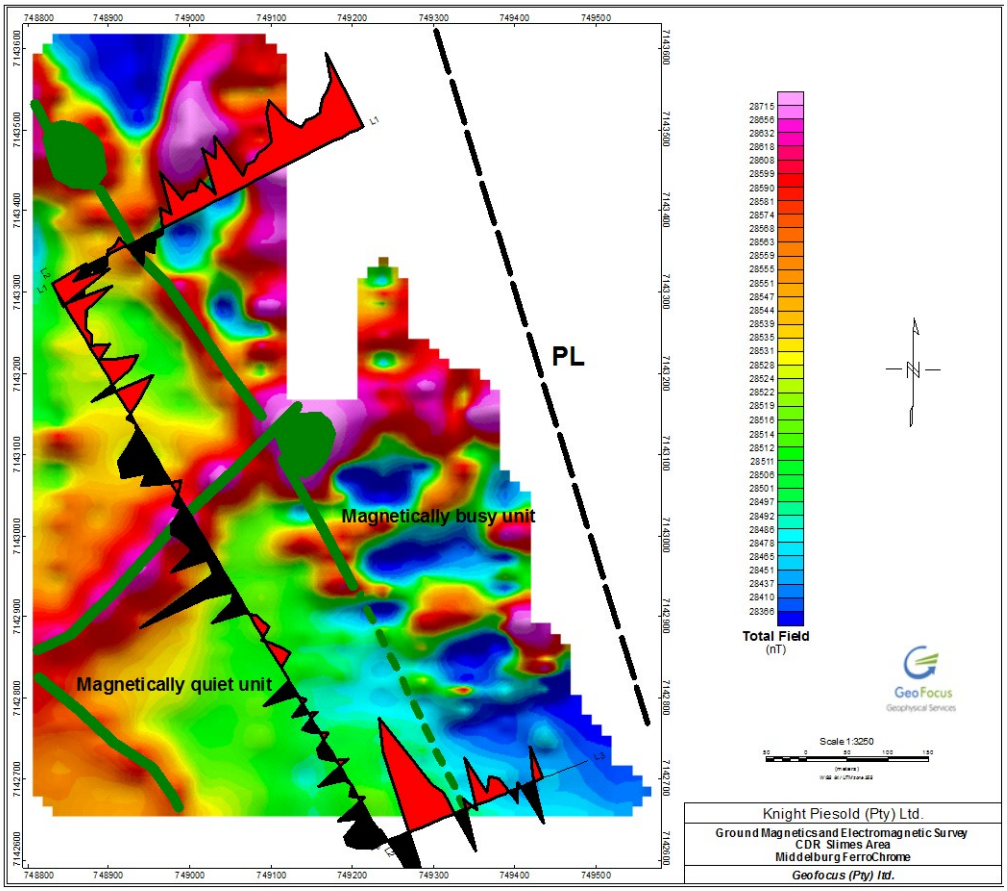

Figure 5 – Vertical dipole EM trace shown in black. Positive values (conductive areas) are red, negative are black.

The vertical dipole (VD) data is better than the HD data. However, neither of the two dykes crossed by lines 1 and 2 show as strong conductors (positive peaks) in either of the two figures. This means they are probably not strong water conduits. The strongest EM feature by far is on Line 3, especially in the VD data (Figure 5) where there is a strong response along the magnetic contact marked by the green dashed line. The VD data indicates that the magnetically quiet lithology to the west is less conductive than the magnetic lithology to the east.

When the magnetic interpretation is overlaid on a satellite image, it appears as shown in Figure 6 below. The NW-SE trending dyke (and geological contact) appears to follow the western edge of the dam paddocks. The slimes dam has been built over the magnetic lithology. The southern magnetic anomaly, interpreted as a small 'blow' or sill, is located right inside one paddock. The NE-trending dyke transects the entire slimes dam and almost certainly continues to the NE beneath the water, where no magnetic readings could be taken. Clearly these structures need to be taken into account for the rehabilitation. If the slimes dam is decommissioned, it will reduce the potential for contaminated slimes to seep into the groundwater via these dykes.

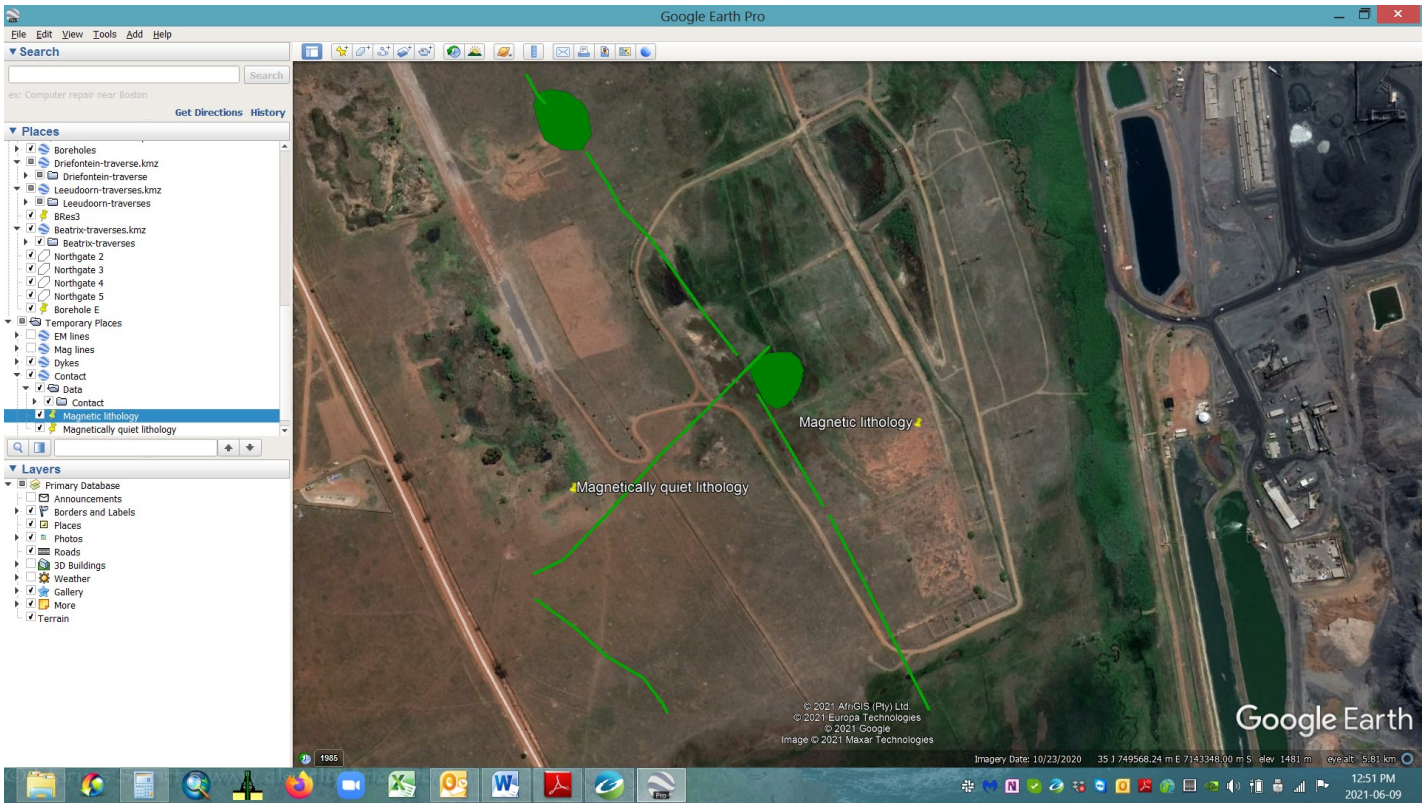

Figure 6 – Interpreted dykes and blows shown overlaid on a satellite image of the slimes dam.

4. Summary and conclusions

The ground magnetic survey over the CDR slimes area has proved very useful for identifying important dyke-like structures and geological contacts. It is a pity that both water and the high-voltage power line impeded the survey in the east and northeast. The ground EM survey was severely affected by the power lines, but has shown that so far neither of the dykes appear to be significant groundwater conduits. The potential for groundwater contamination along the dykes will be greatly reduced by decommissioning this slimes dam. The EM survey also strongly confirmed the geological contact along EM line 3.

G. R. Selfe