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Loupe Surveys for Mineral Exploration and TSF Investigations

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SUMMARY

Since last presenting results at an AEGC conference, Loupe TEM systems have completed dozens of surveys for mineral exploration, groundwater and engineering applications in Africa, Europe, North America and Australia. The ease of use, portability and bandwidth have seen it applied to mineral exploration and geological mapping for base metals, graphite and diamonds as well as many studies of tailings storage facilities, wetlands, clay mapping, groundwater exploration, void detection and archaeology.

Results will be presented from Loupe surveys for mineral exploration and tailings storage facilities (TSF). We will illustrate the use of the Loupe system in a range of configurations, including moving-loop and fixed-loop and will present data generated by measuring fields from VLF stations and power transmission lines.

INTRODUCTION

Since first presenting a paper about the new portable Loupe TEM system at the AEGC in Sydney 2018 (Street et al, 2018) we have been commissioning new systems and training new customers, carrying out demonstration surveys, developing new processing products for Loupe data and improving the performance of the system. We envisaged in Sydney that the Loupe system had application in:

1. Mapping water content in tailings dam walls
2. Mapping clay pods in iron ore mining operations
3. Mapping seepage from tailings dams
4. Mapping acid drainage from mine dumps
5. Mapping black combustible shale horizons in iron ore mines
6. Detecting voids from old mining operations
7. Mapping of sulphide ore near to surface
8. Underground mapping of disseminated or massive sulphide ores
9. Mapping boundaries between geological units with a range of electrical properties
10. Routine exploration for base metals, graphite, manganese and gold.

We have found that all these applications have been trialled with some degree of success by users of Loupe systems.

TAILINGS STORAGE FACILITIES

In the mining industry, tailings storage presents major technical and logistical problems. Failure of a tailings storage facility (TSF) can result in significant environmental/other damage and loss. This was the case on 5 November, 2015, when a TSF at an iron ore mine site at Bento Rodrigues, near Mariana, Minas Gervais, Brazil, suffered a catastrophic failure resulting in considerable environmental damage and human loss(Wikipedia, 2022a). The Brumadinho dam disaster occurred on 25 January, 2019 when a TSF at an iron ore mine near Brumadinho, Minas Gerais, Brazil, suffered a similar catastrophic failure with human loss (Wikipedia, 202b2). Similar failures are not unusual with at least 16 known failures worldwide since Brumadinho.

Irrespective of the potential for catastrophic failure, most TSFs leak fluids to some degree. Without evaporation and/or seepage the TSF would become more and more unstable. However, environmental regulations stipulate at least in advanced jurisdictions that there be no seepage to the surrounding environment and any seepage should be detected and pumped back into the facility.

Due to their relatively non-invasive nature, geophysical techniques are commonly used in investigations of the integrity of, and seepage from, TSFs (Martínez-Pagán, 2001; Mollehuara-Canalesa, 2021; Tycholiz, 2016). Resistivity and EM are the most popular methods. Resistivity methods tend to be slow and are most sensitive to resistive geology – seeps and areas of increased moisture content are typically conductive. Most of the EM techniques used historically have been single frequency systems and do not provide the depth information that could be obtained with resistivity arrays. Time domain EM systems are mostly slow to use and have not been able to resolve near surface conductivity variations.

The Loupe (Street et Al. 2018) system is ideally suited to TSF investigations. It is safe (no exposed high voltages), easy to mobilise to site and can be used wherever the operators can walk while providing a depth section similar to resistivity surveys. Loupe data is collected dynamically while operators are walking and considerable ground can be covered quickly.

Figure 1. Loupe system deployed at mine site for TSF investigations. Data is collected at walking pace.

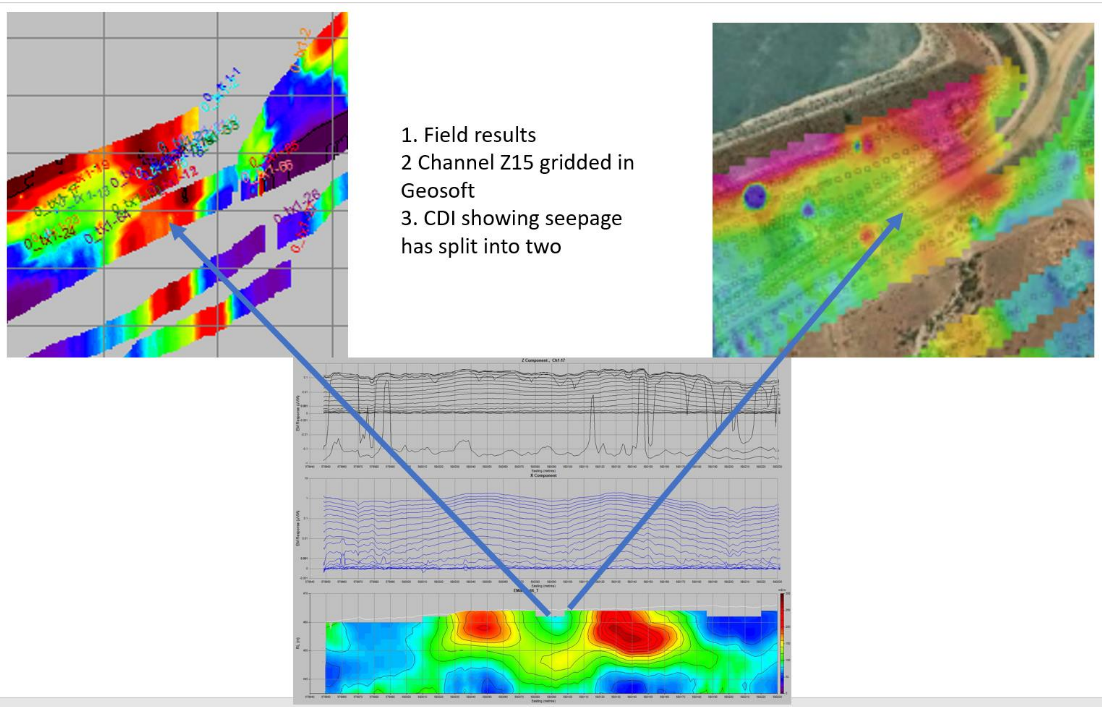

Figure 2. Results of Loupe survey showing likely seepage from a TSF. Raw results, gridded Z component, time channel 15 (centred 210 microseconds after transmitter switch-off) and a CDI showing likely seepage of tailings material.

MINERAL EXPLORATION EXAMPLE

A greenfields gold and base metals play at Cubbine, in the wheatbelt of Western Australia was used as a test site for Loupe during its development. The site is in farming country with fences and powerlines, and some areas of uncleared bushland. Basement is highly deformed – Archean granulite terrain with significant alteration present. Copper exploration was first undertaken here by Shell Minerals in the 1960s and Sentinel Exploration has been doing new work on the prospect.

Figure 3 shows an example of Loupe data on a 500m long traverse over a conductive bedrock feature. It was collected using:

- 75 Hz transmitter frequency
- Transmitter moment around 100 ATm^2
- 10m tx-rx spacing
- Real-time processing to remove the effects of powerline interference and system motion
- Storage of raw time-series data
- Window times 4 usec – 2.5 msec
- Each reading is a stack of 2 seconds of data
- Parallaxed to tx-rx centre
- 50m line spacing

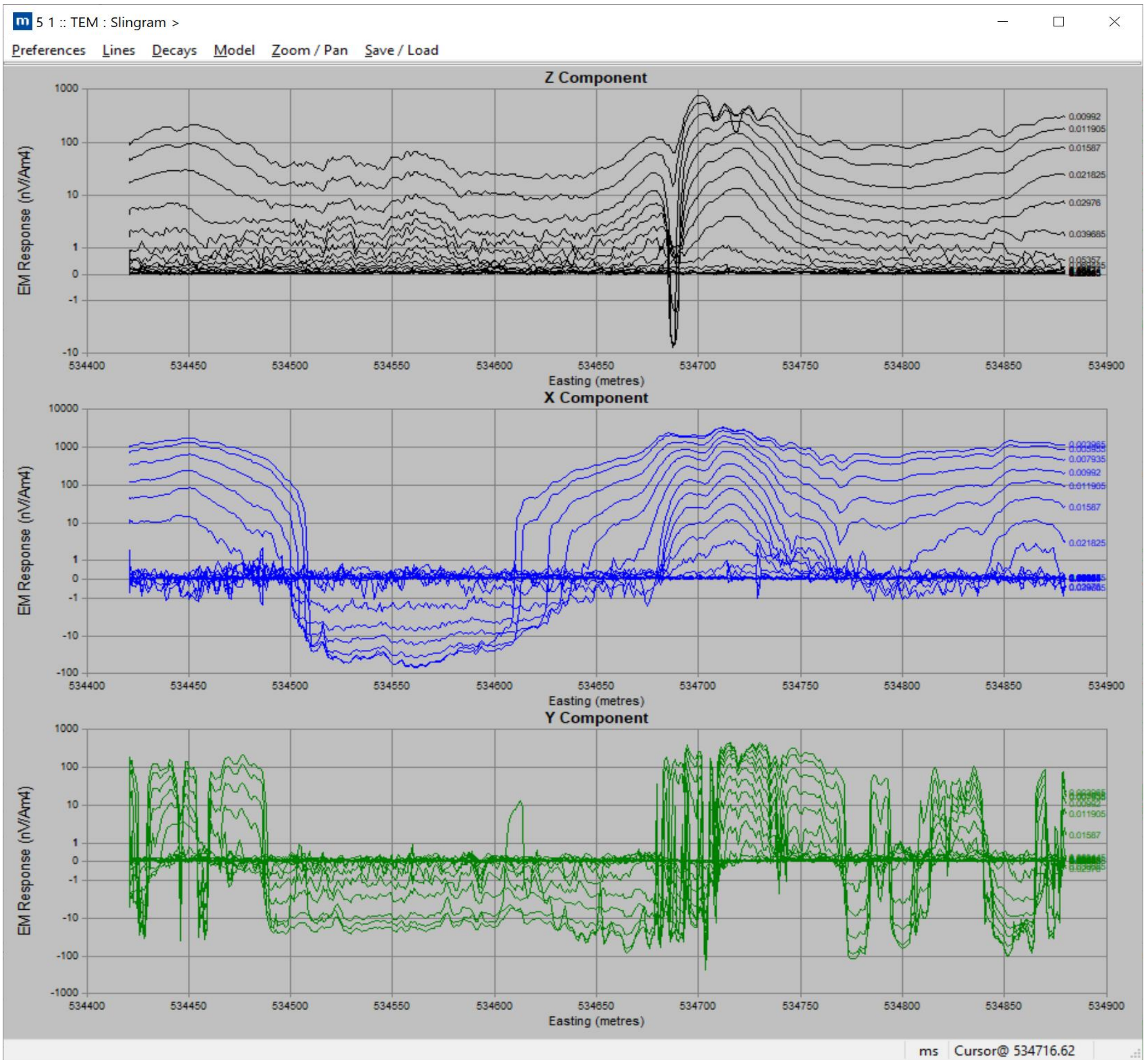

Figure 3. Three component Loupe data profiles over a conductive basement feature at Cubbine.

Figure 4 shows gridded Loupe data which highlights electrically-conductive features in the weathering profile and basement (northern half of the survey) and in transported material (southern half). This data was collected to track observed conductive features, some of which outcropped in gossanous material. This survey was carried out with an average of more than 15 km of Loupe data collected per day, even in the prevailing very hot conditions.

We will also present other data derived from the raw Loupe survey data, including VLF responses (North-West Cape) and responses measured at power line frequency – two by-products of recording raw time-series.

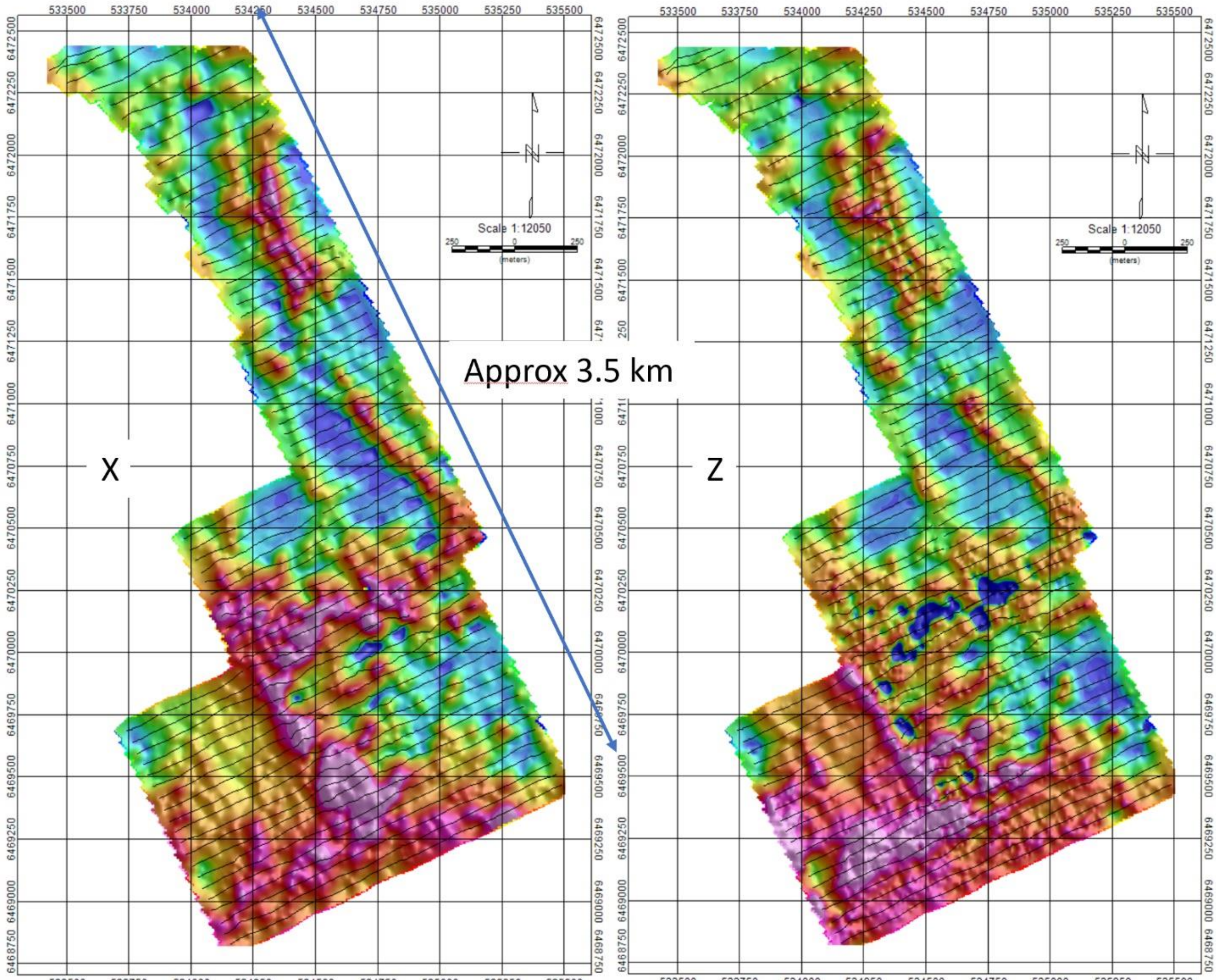

Figure 4. Gridded X and Z component Loupe data collected over the Cubbine prospect in Western Australian Wheatbelt. Data from time channel 4 centred 9 microseconds after transmitter switch-off.

CONCLUSIONS

Loupe is a portable TEM system collecting data while the operators are traversing at normal walking pace. It is capable of producing TEM data with high spatial resolution (vertical and horizontal). This system has been designed to operate well in urban areas and areas with significant interference from powerlines and other infrastructure.

Data presented highlights the usage of Loupe in mineral exploration and environmental applications.

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