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Best practices for ultra-high resolution magnetic and radiometric statewide merges

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SUMMARY

Statewide geophysical grid merges are typically created using regional government-funded surveys. The merge products generally have grid cell sizes between 40–50 m due to typical regional survey line-spacing occurring in the 200–250 m range. On a statewide scale, these products provide an excellent overview of regional geological features. However, any geophysical surveys flown at less than 200 m line-spacing lose their finer details in the process.

Geophysical grid merging is a complicated technique which can be enhanced by following a series of best practices in the preparatory stages. Since 2020, the Geological Survey of NSW (GSNSW) has updated its statewide geophysical merges iteratively, and as a result has generated a fully documented procedure to allow seamless iterations upon existing products.

Latest statewide geophysical merges in NSW are performed at a cell size of 25 m, a fourfold increase in data resolution to previous merges. Additionally, these same merging practices allow the creation of a 10 m cell size regional merge over central NSW – highlighting the wealth of high-resolution company data over areas of high prospectivity.

Key words: geophysics, NSW, magnetic, radiometric, merge

INTRODUCTION

Since 2020, the Geological Survey of NSW has completed updates of its statewide geophysical merges iteratively, at ultra-high resolution to make the most of high-resolution open-file company data (Figure 1). Exploration and mining companies are required to submit all geophysical data on an annual basis and under typical circumstances, these data are granted five-year confidentiality periods. Once these surveys are open file, they are eligible for inclusion in the NSW statewide geophysical products.

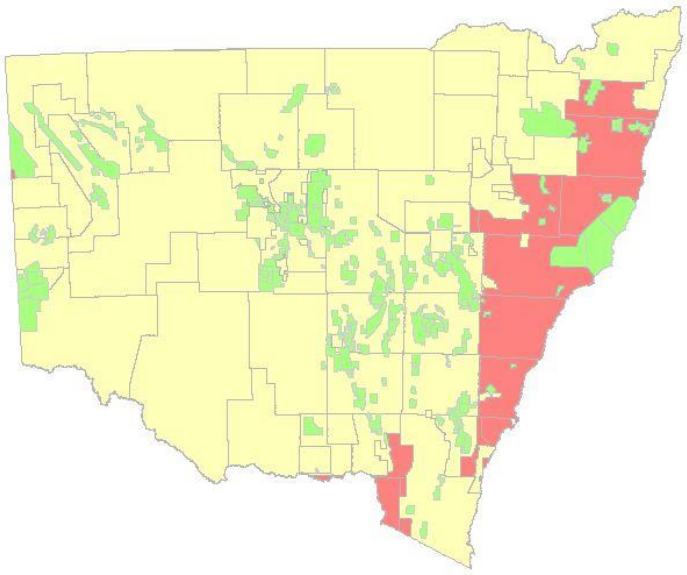

Figure 1. Map of the survey composition of the 2022 NSW magnetic merge (Matthews, 2022a). Red represents low quality legacy data; yellow represents modern regional government data; and green represents company data.

QA/QC is imperative before any merge. To determine whether the quality of company data is adequate to warrant inclusion in the merged products, GSNSW has created an algorithm to quantitatively assess survey specifications. Aspects such as line-spacing, flight height, sampling rate, and many others are taken into account (see below in Figure 2).

Merging numerous geophysical surveys into one final product is a process that can be significantly refined. Using default parameters and methods will generate a working output grid; however, following the series of best practices described herein will ensure a higher quality result for the final product.

METHOD AND RESULTS

Quality Assurance and Quality Control (QA/QC)

Beginning in 2018, GSNSW commenced the QA/QC process of more than 900 airborne geophysical surveys acquired in NSW since the 1950s. Beyond the manual assessment of the survey data, an algorithmic approach is also used. An algorithm was created that allowed quantitative assessment of each survey by applying a weighted score (Figure 2) to different survey parameters such as line-spacing, flight height, sampling interval and survey area. Upon applying this algorithm to the surveys comprising the legacy (2014) statewide merge, a 'baseline' score was determined, forming a benchmark for all future surveys. The algorithms for the magnetic and radiometric survey quantification are defined below:

Magnetic: ([Line Spacing] / [Clearance] / [Area] / [Sampling] / [Bearing] / [Year]) * 100.
Radiometric: ([Line Spacing] / [Clearance] / [Area] / [Sampling] / [Crystal Size] / [Channels] / [Bearing] / [Year]) * 100.

Line Spacing (m)	
<=100	4
101-150	2
151-200	1.5
201-250	1
251-400	0.75
>400	0.5

Clearance (m)	
<=50	1
51-75	1.25
76-100	1.5
101-150	3
151-200	4
>200	8

Area (km2)	
>=1000	0.8
500-999	0.9
100-499	1
50-99	2
25-49	4
<25	8

Rad Sampling (Hz)	
>=2	0.8
1-2	1

Crystal Size (L)	
>=32	1
<32	2

Mag Sampling (Hz)	
>=20	0.8
10-19	1
5-9	2
<5	4

Bearing (Strike+-)	
>=45	1
<45	3

Year (GPS)	
>=1992	1
<1992	4

Channels (#)	
256	1
3	1.2
<3	10

Figure 2. Weighted look-up tables used in the quantitative assessment algorithms for the magnetic and radiometric merges (Matthews, 2022a,b).

Merge procedure

A series of oft-skipped steps form the best practices for ultra-high resolution geophysical merges. These steps are:

1. Unify input grid projection
2. Unify input grid sampling
3. Determine precise grid layering with highest quality grids layered at the top
4. Clip and buffer input grids leaving only a small region of overlap.

When dealing with surveys with different grid cell sizes, it is important that the line data is sampled correctly before any resampling is performed. Conventional wisdom dictates that the ideal grid cell size is no smaller than 20% of the survey line spacing. If a desired cell size for the merged product is lower than 20% for any given survey, then the grid must initially be created as outlined above, before being resampled smaller – avoiding any inaccurate interpolation of data values.

Precise layering of surveys is performed by GSNSW primarily using the algorithm defined in Figure 2. In cases where surveys sharing identical algorithm scores overlap, typically the newest data is chosen (after visual inspection of each grid).

The final preparatory step of the merge procedure is to clip and buffer overlapping grids. This stage is most often overlooked in favour of simply merging the grids per the layering in step #3 above. While it is crucial for the software to match features between the joining grids – it is best to limit this to a small boundary region of the join. This serves to prevent any inaccurate interpolation and allows confidence that the very best data is being displayed throughout the survey area.

CONCLUSIONS

GSNSW has iterated its statewide geophysical merges since 2020 using a series of both learned and pioneered best practices. Easy replication is assured, using a stable workflow to generate a platform on which future iterations of the NSW statewide merges can be integrated.

ACKNOWLEDGMENTS

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