Drone-magnetic survey along the Alentejo coast (SW Portugal): a quest for the intruded Messejana fault

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Contents

Introduction

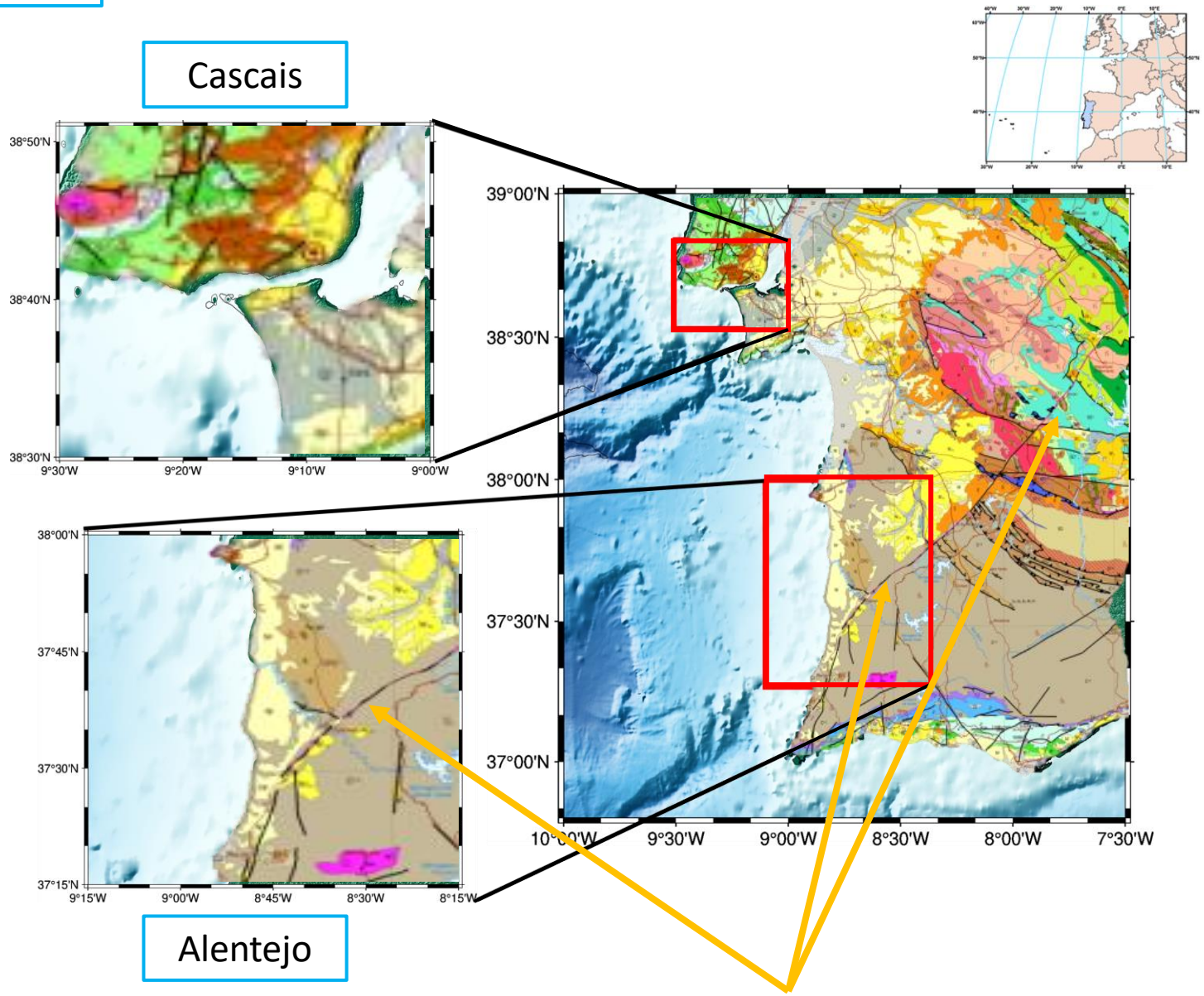
- The Messejana fault is a 500 km long crustal-scale left-lateral strike-slip fault of Permian age, which cuts across half of the Iberia Peninsula

- The offshore prolongation of the Messejana fault and dyke towards SW is generally assumed. However, its exact location is unclear since its trace is mostly lost close to the coastline under Cenozoic sedimentary cover. It may be offset by N-S faults or splay into different segments, and how it continues to offshore is not documented

Main Goals

- Compare magdrone data obtained oversea and overland
- Compare magdrone data with the marine magnetometer data for the same region
- Use the magdrone data for geologic interpretation: identify magmatic structures such as dikes and the possibility of the Messejana fault bifurcation

Study Region



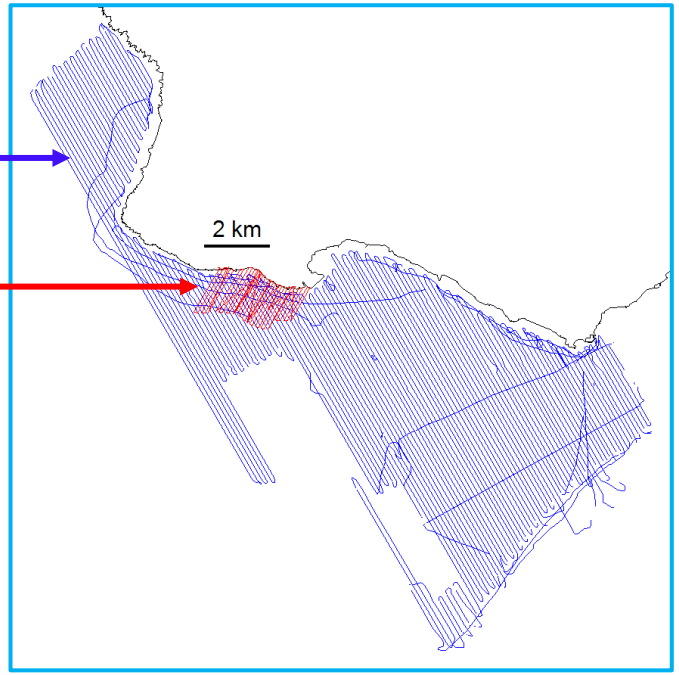
- The Messejana fault

Data and Sensors

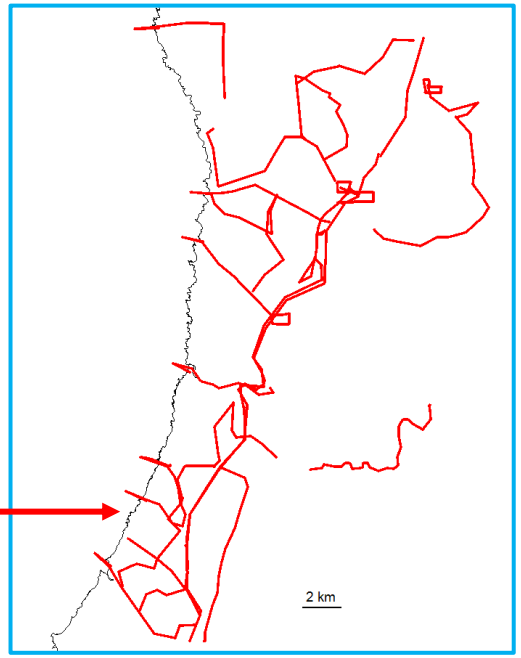
Marine Magnetometer G-882 (Geometrics)
→ blue lines

MagDrone R3 FGM3D/100 (Sensys)
→ red lines

Cascais



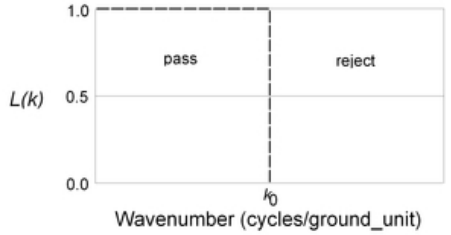
Alentejo



Features \ Names	MagDrone R3 FGM3D/100	Marine magnetometer G-882
Sampling Rate	200 Hz	<20Hz
Sensor	three-axis Fluxgate	Cesium Vapor
Measurement Range	±75,000 nT	20,000 nT to 100,000 nT

Processing

Low-pass Filter



L(k) = 1, for k £ k0
L(k) = 0, for k > k0

Parameter:

k₀ The cutoff wavenumber in cycles/ground_unit. All wavenumbers above this value are removed.

Oasis Montaj software

- Calculation of IGRF and MagAnom
- Base station correction
- Elimination of lines
- Lines splitting
- Truncation
- Low Pass filters
- Leveling
- Data extrapolation

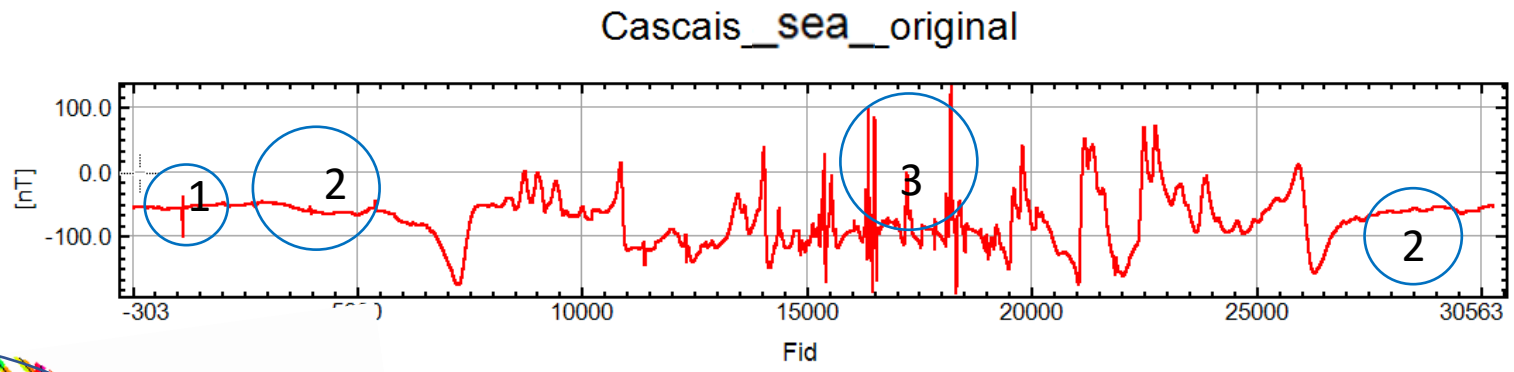
Iterative Levelling

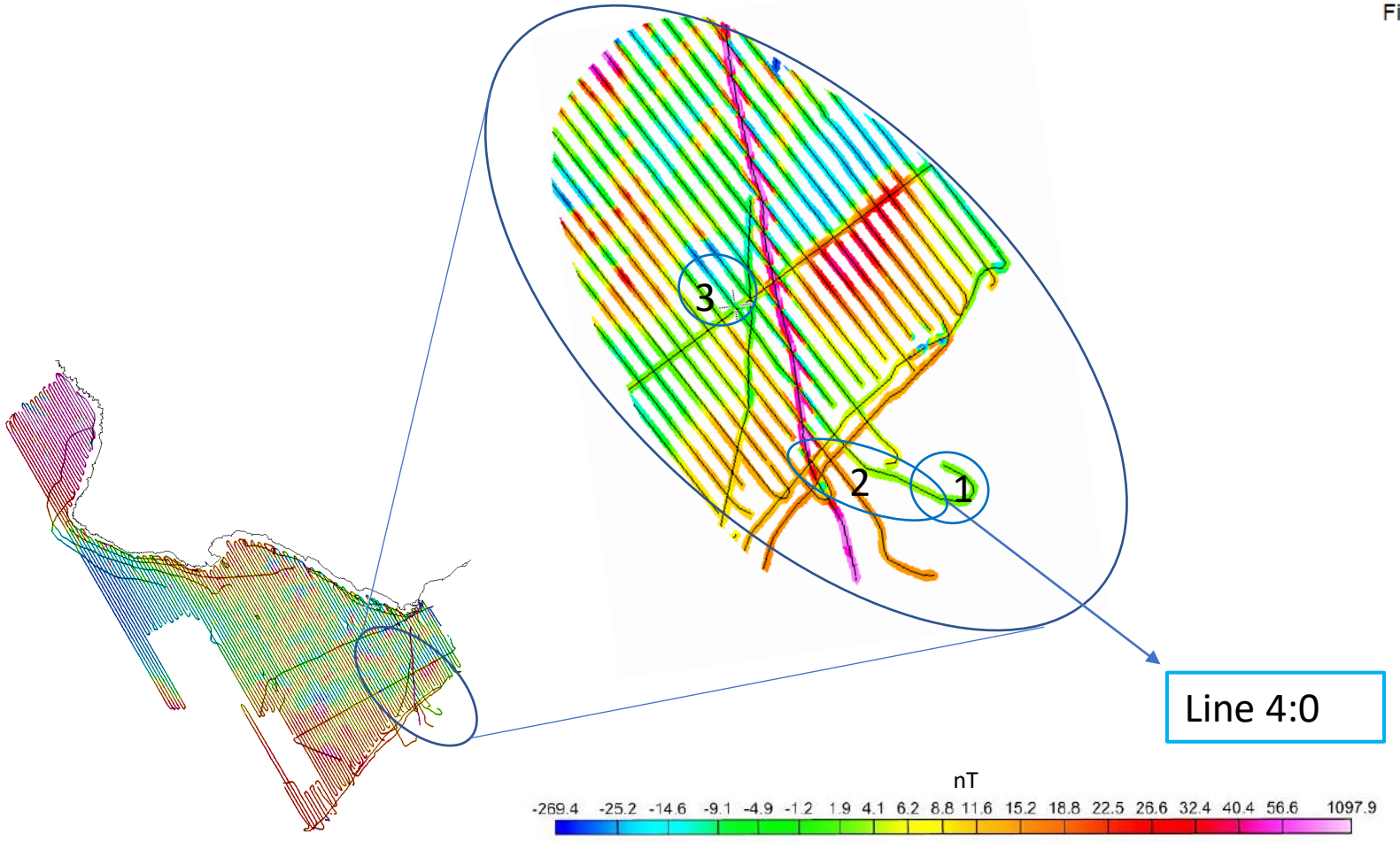
The Iterative Levelling GX combines the operations of the INTERSCT, XLEVEL, STATLEV GXs in a single operation which levels the tie lines to the flight lines, and the flight lines to the ties, until the process converges to a final solution. Before the initial levelling, and after each iteration, the standard deviation of the mis-tie values at the intersections is displayed, allowing the user to track the convergence to the final solution, and also to end the process if a solution is deemed to be achieved before the full number of iterations is reached.

Cascais

Magnetic anomaly original sea data

Line 4:0



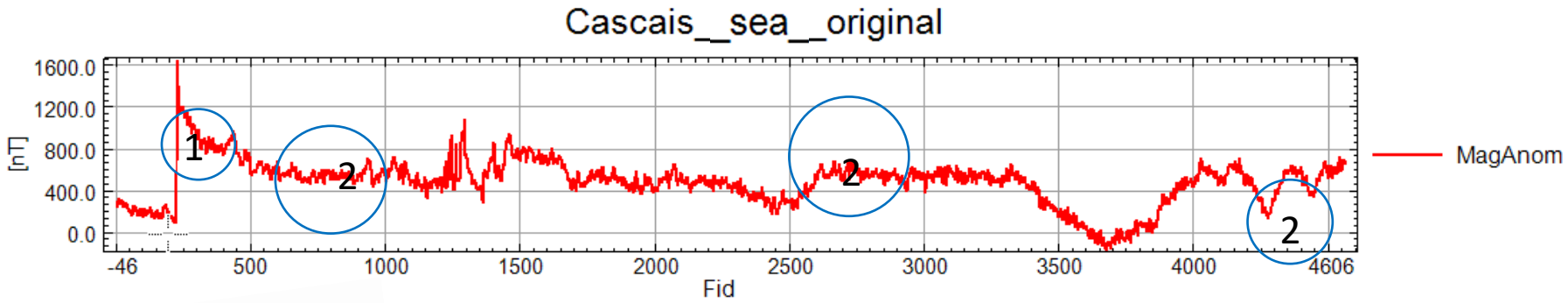


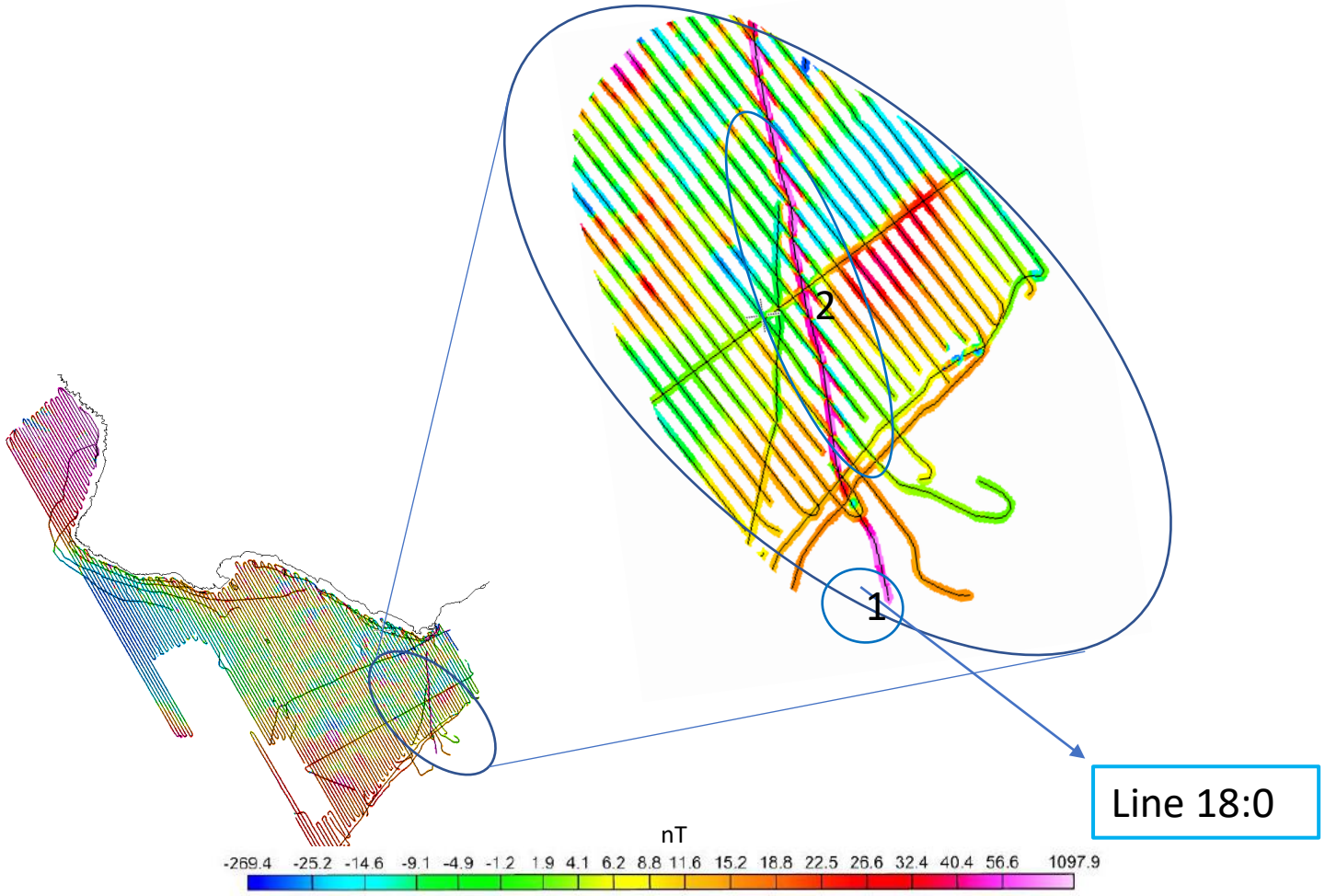
1 –spike associated with direction change

2 – Real value

3 – High real values

Line 18:0



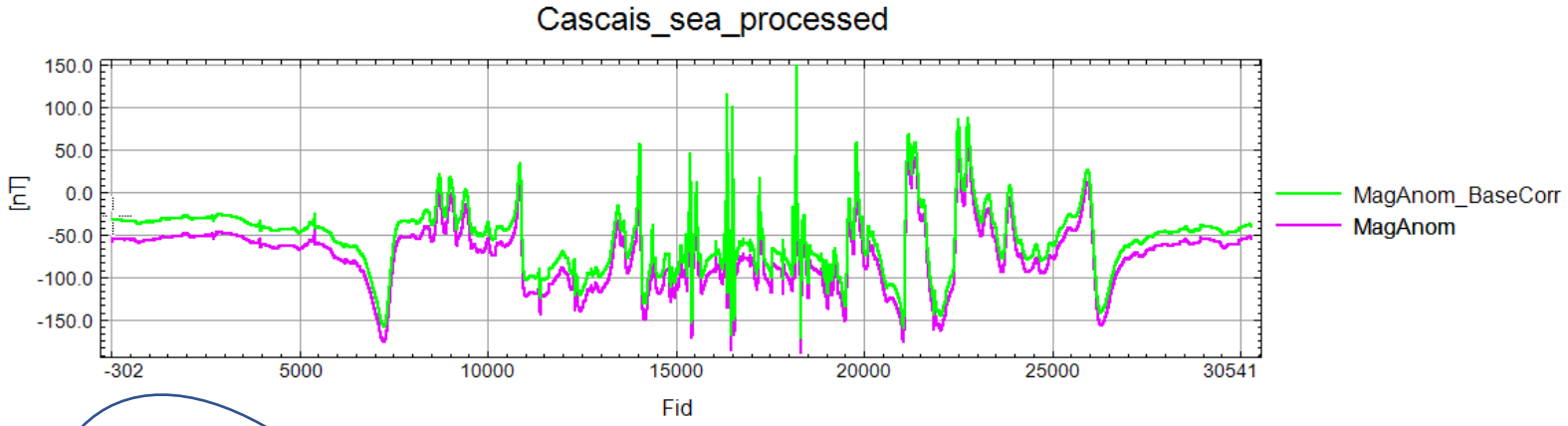


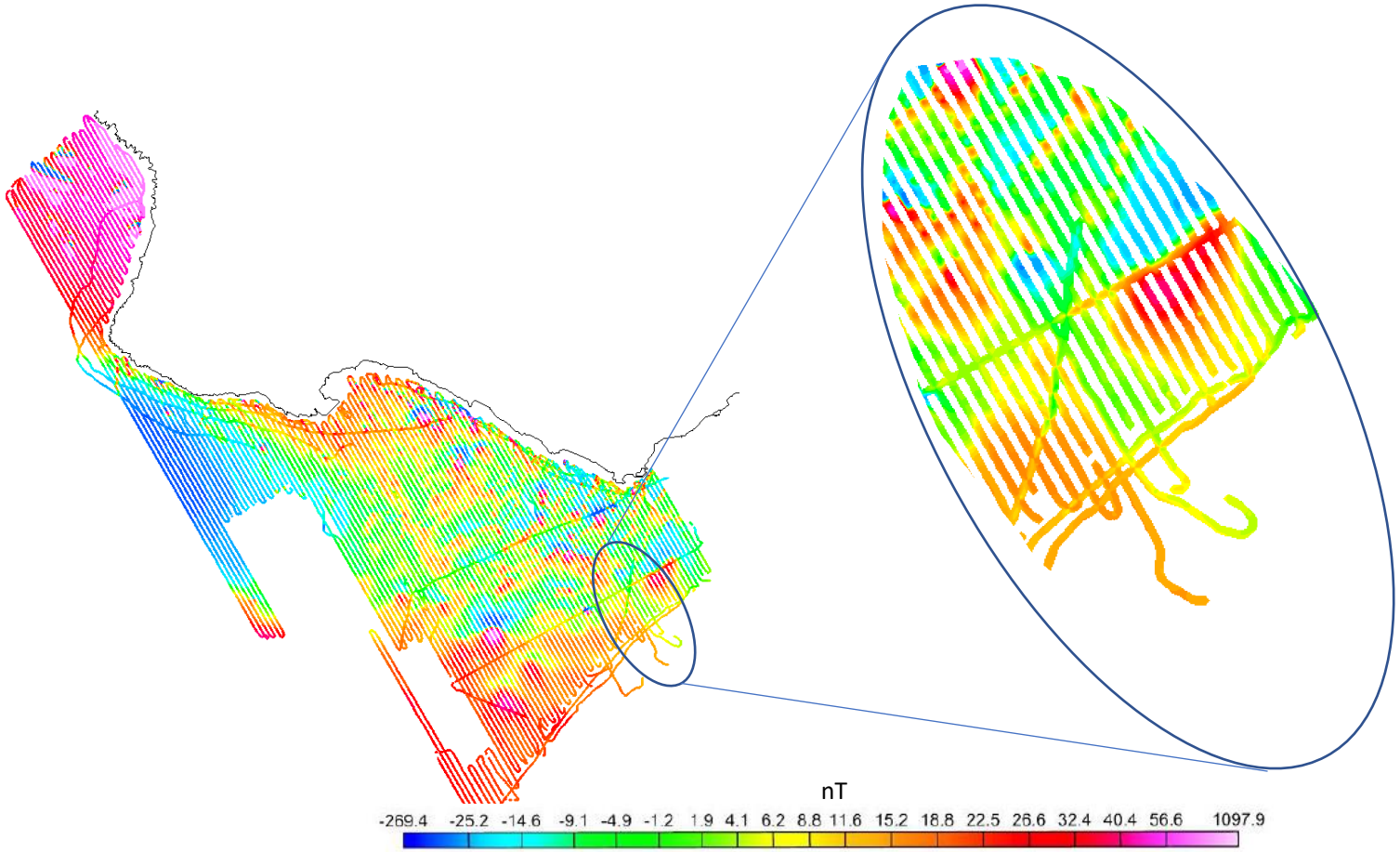
1 –step signal

2 – Line full of noise

Line 18:0

Magnetic anomaly processed sea data



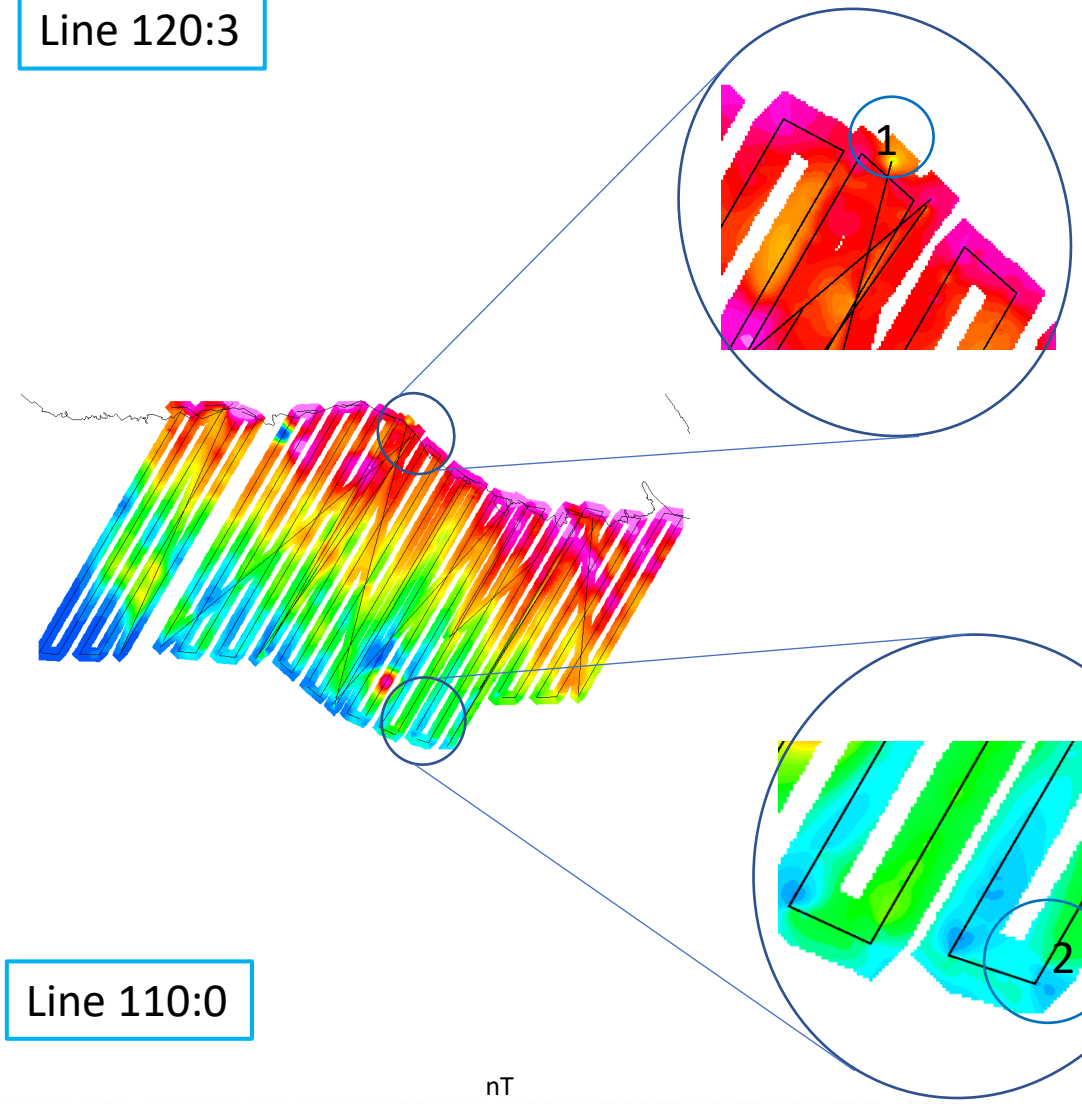


- The elimination of the high noise line was the best decision
- The base station correction removed unreal signal fluctuations

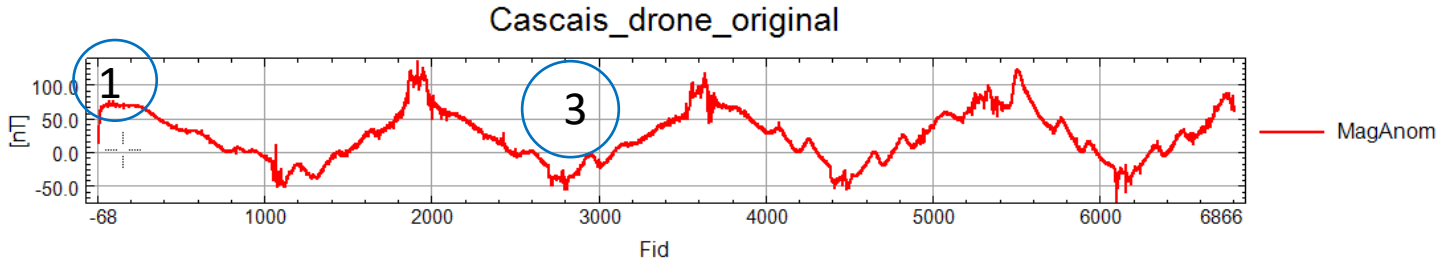
Cascais

Magnetic anomaly original drone data

Line 120:3



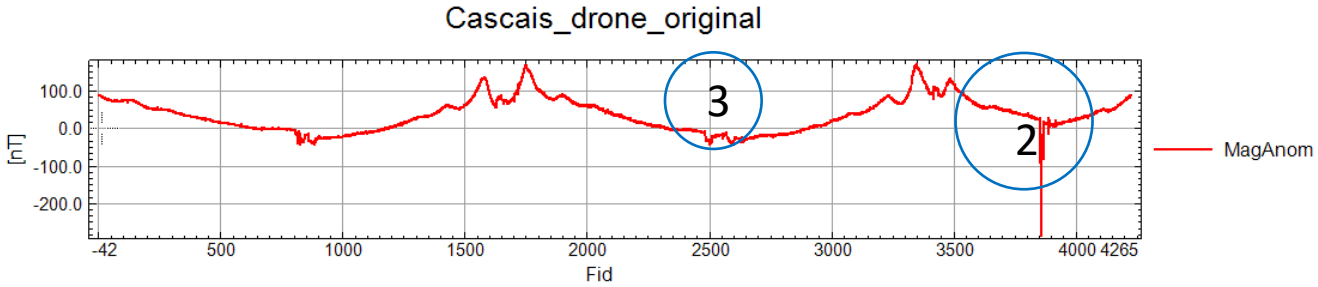
Line 110:0



1 – High negative spike associated with the drone start

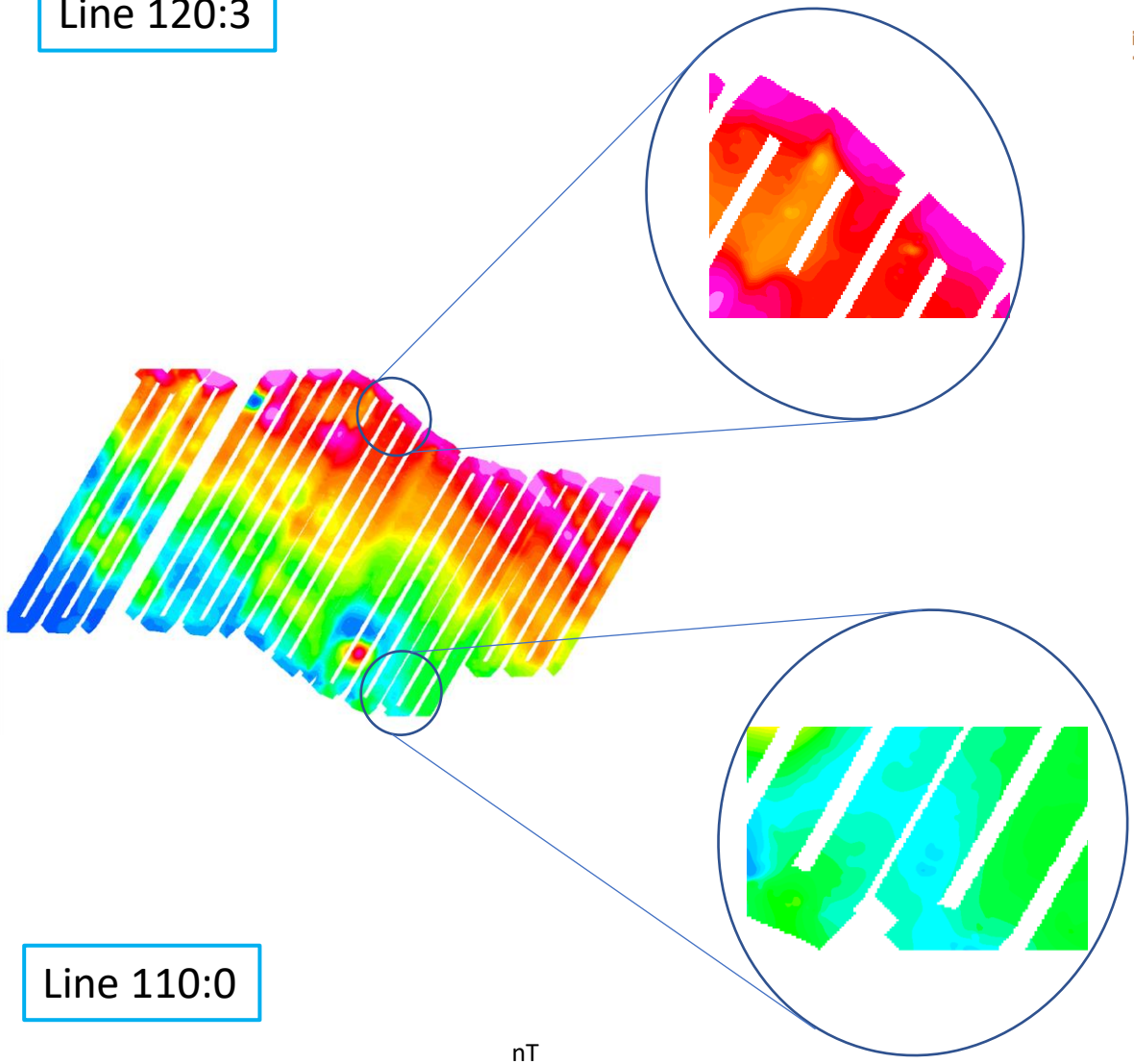
2 – Changes of direction originating several negative spikes

3 – Splitting the line in smaller lines

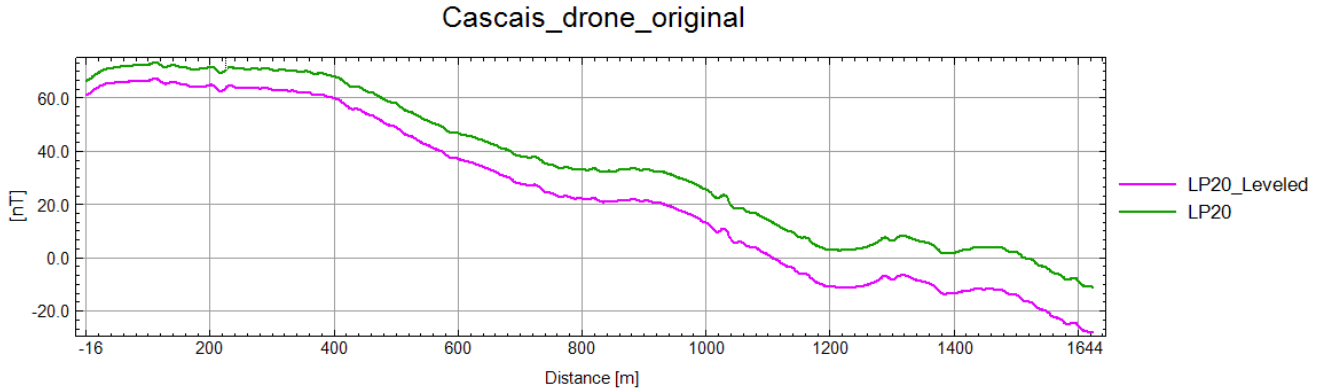


Magnetic anomaly processed drone data

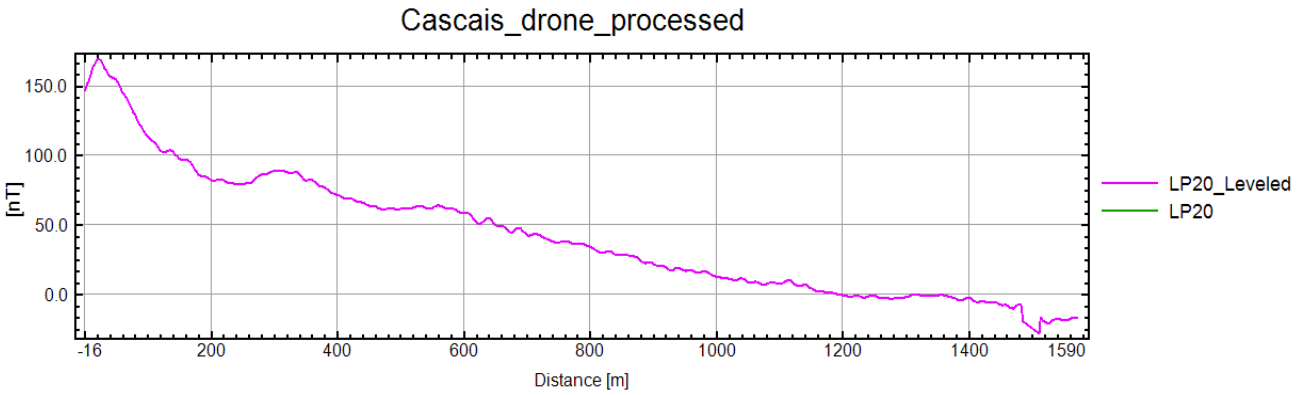
Line 120:3



Line 110:0



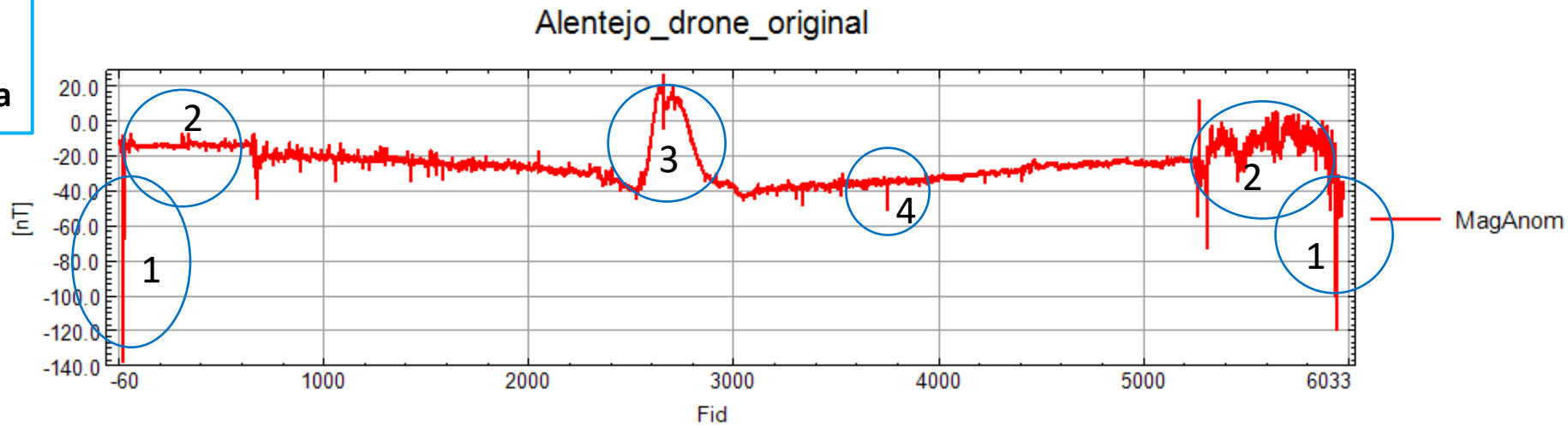
- The low pass filter was able to reduce the noise created by the drone
- The leveling allowed close lines (parallel) to have similar values
- The elimination of spikes removed unreal values

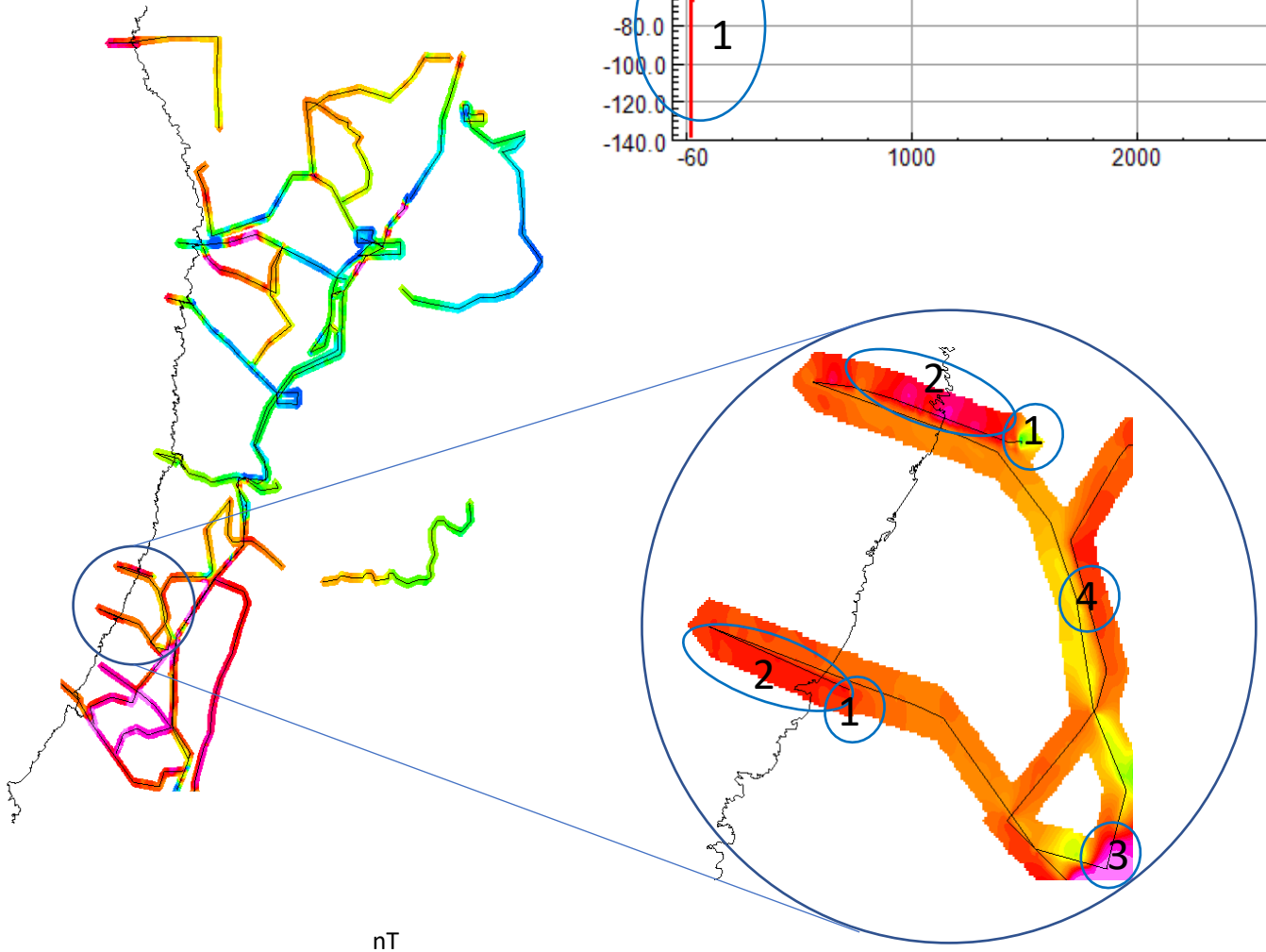


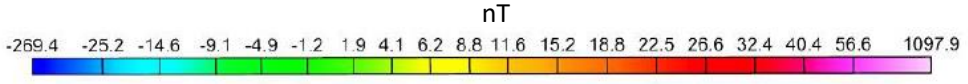
Alentejo

Magnetic anomaly original drone data

Line 16:11



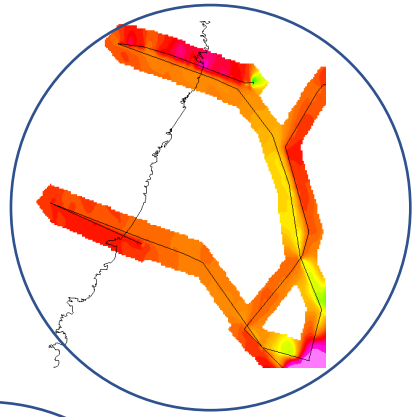


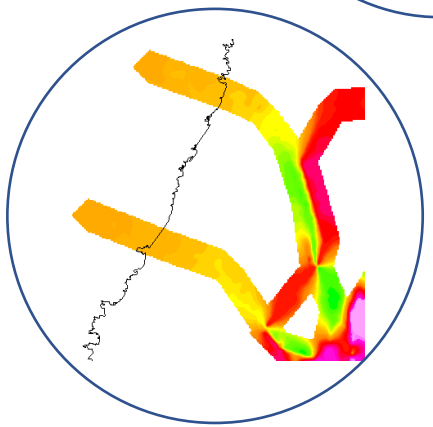


1 – High negative spike associated with the movement start or stop (change of velocity)
2 – Parallel lines with a step signal
3 – Real value
4 – Change of direction

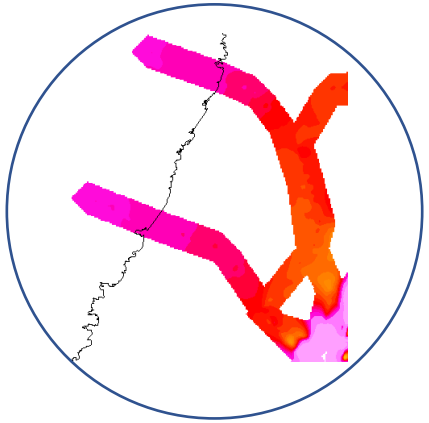
Magnetic anomaly processed drone data

Line 16:11

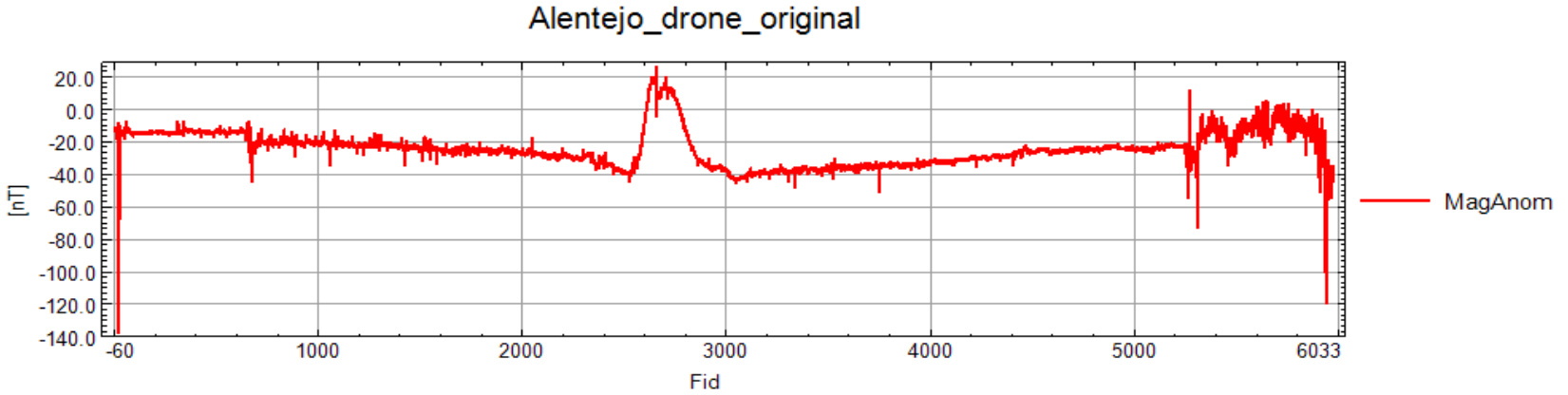


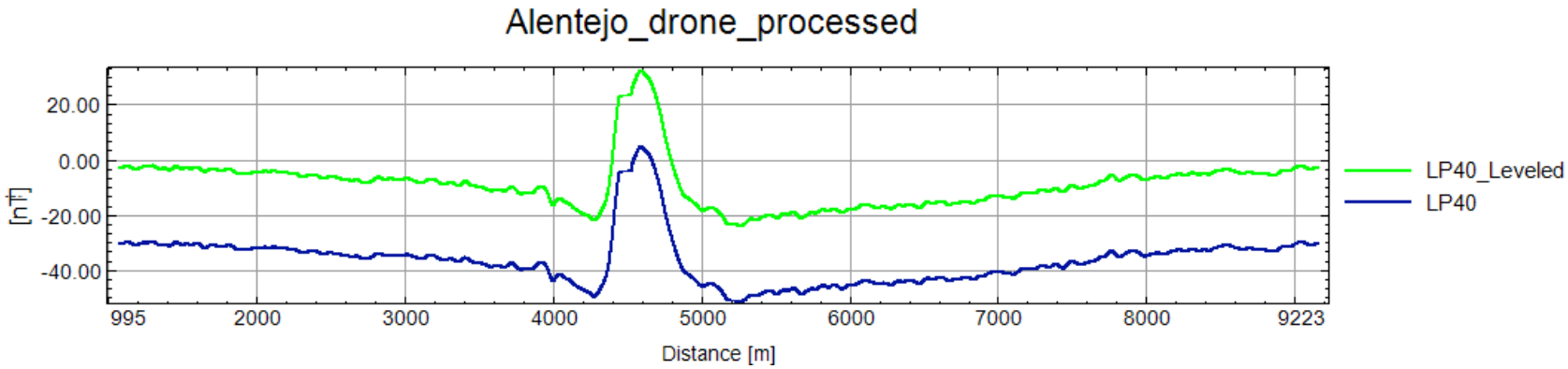


LP40



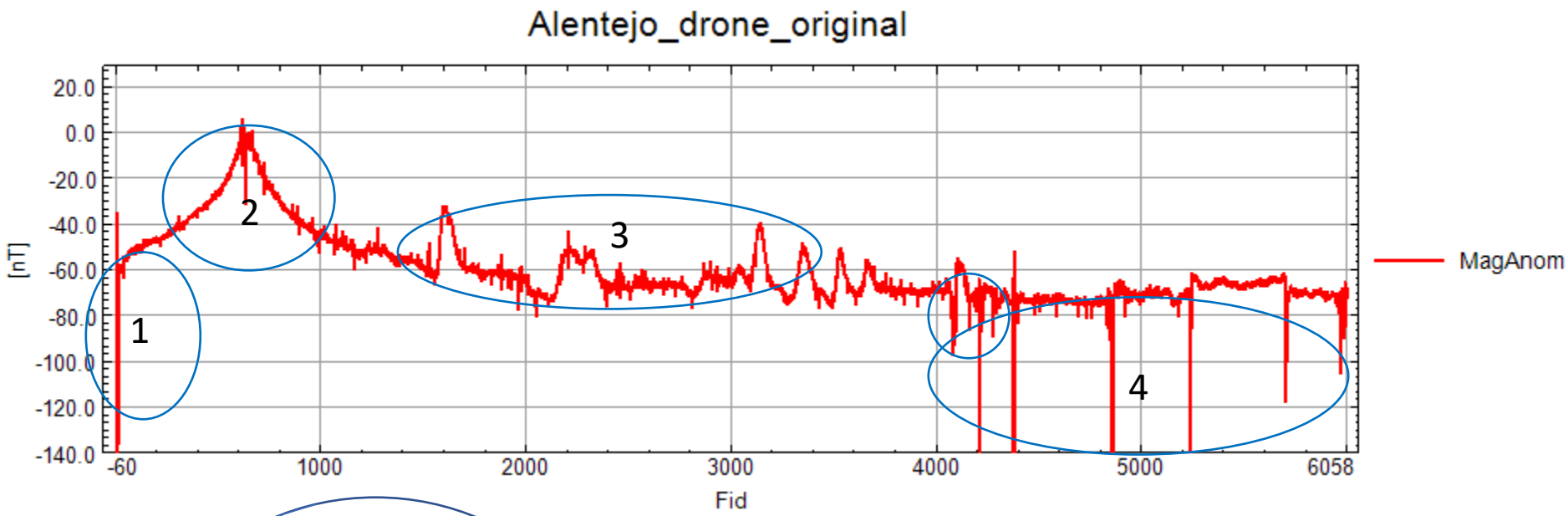
LP40_Leveled

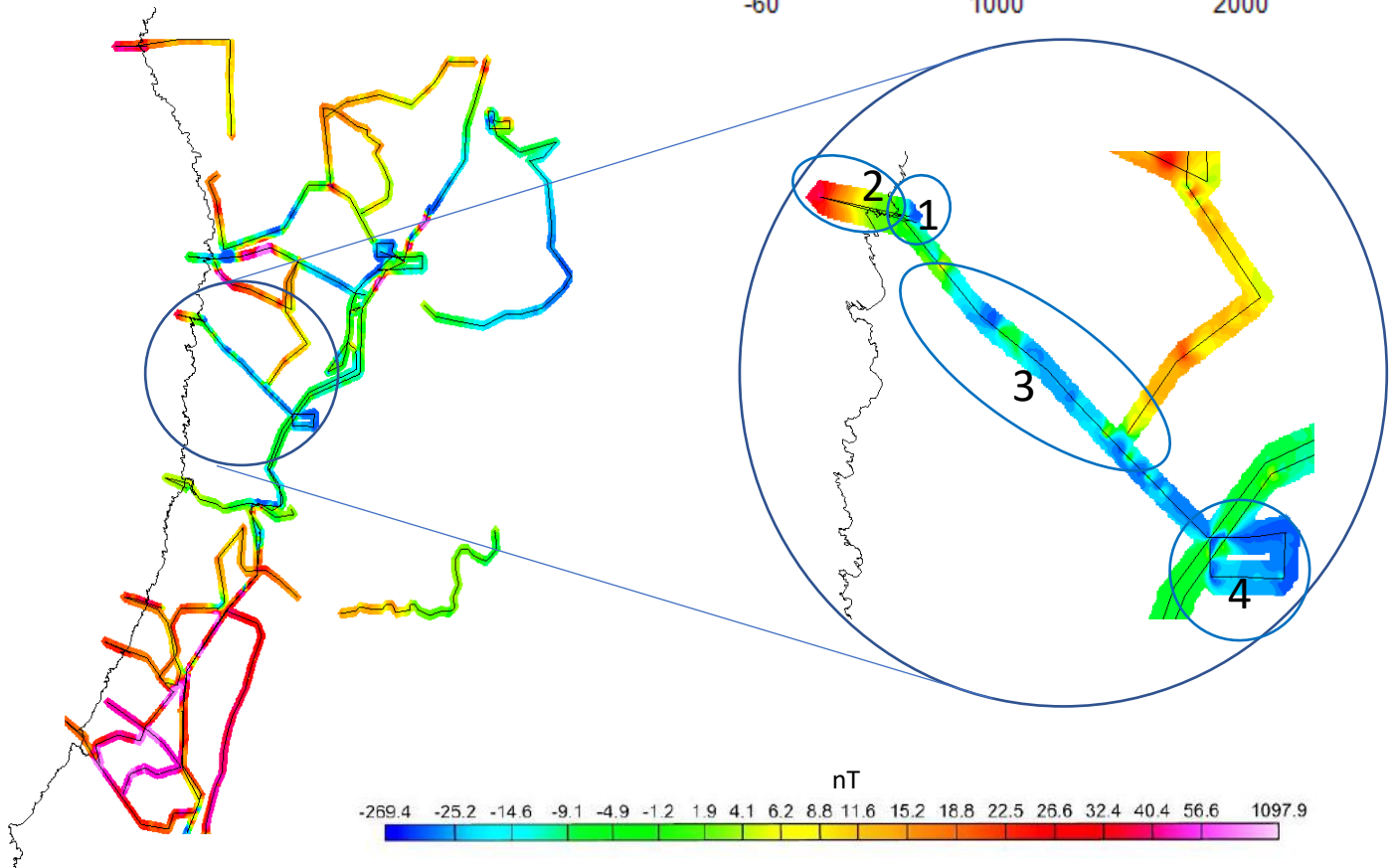




- The low pass filter was able to reduce the noise created by the drone
- The leveleing allowed close lines (parallel) to have similar values

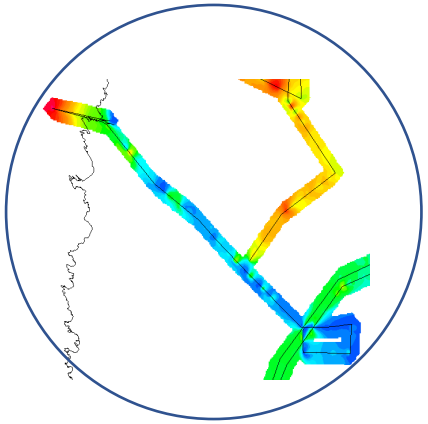
Line 16:13

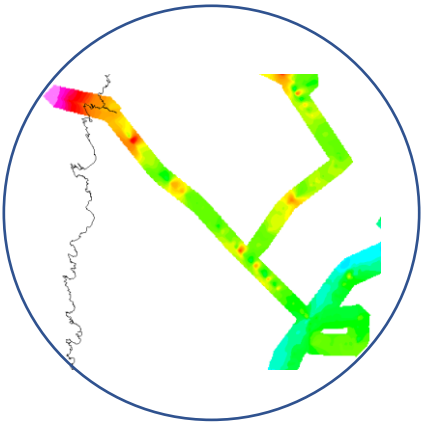




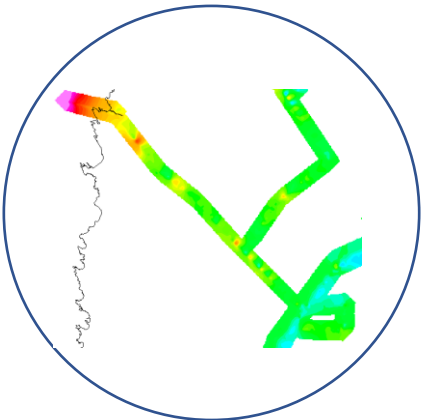
1 – High negative spike associated with the movement start or stop (change of velocity)
2 – Symmetric value despite of change of direction
3 – Real value
4 – Changes of direction originating several negative spikes

Line 16:13

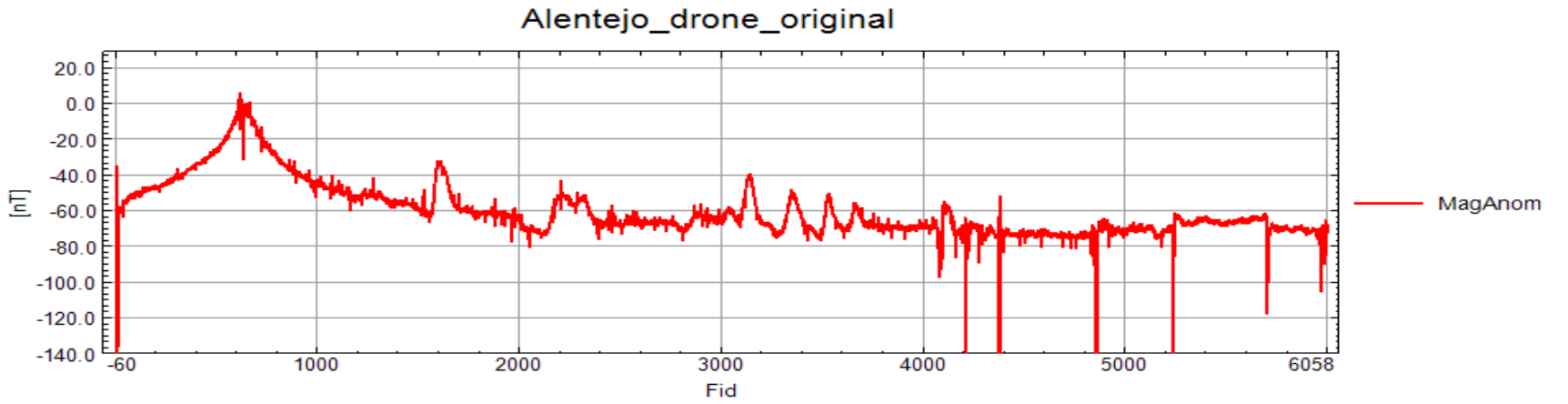


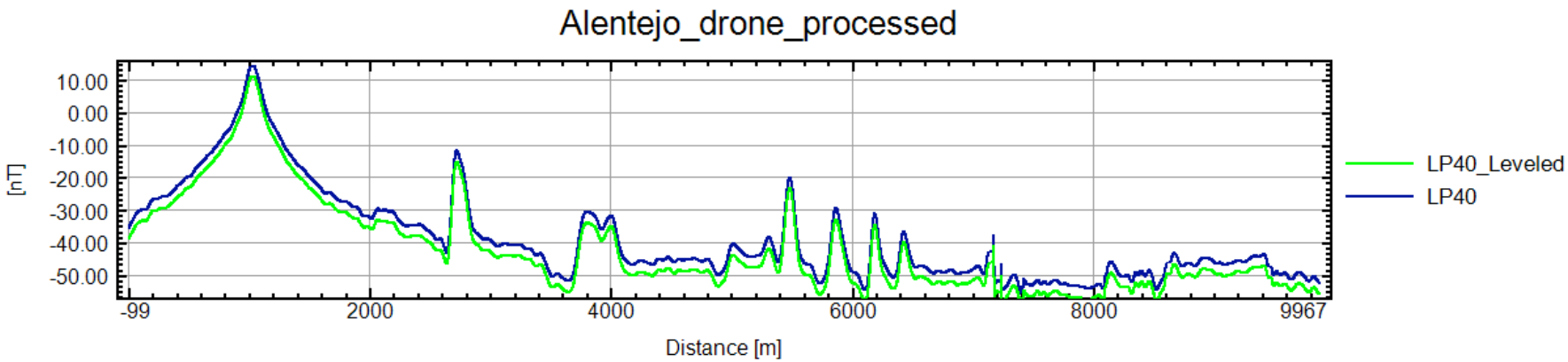


LP40



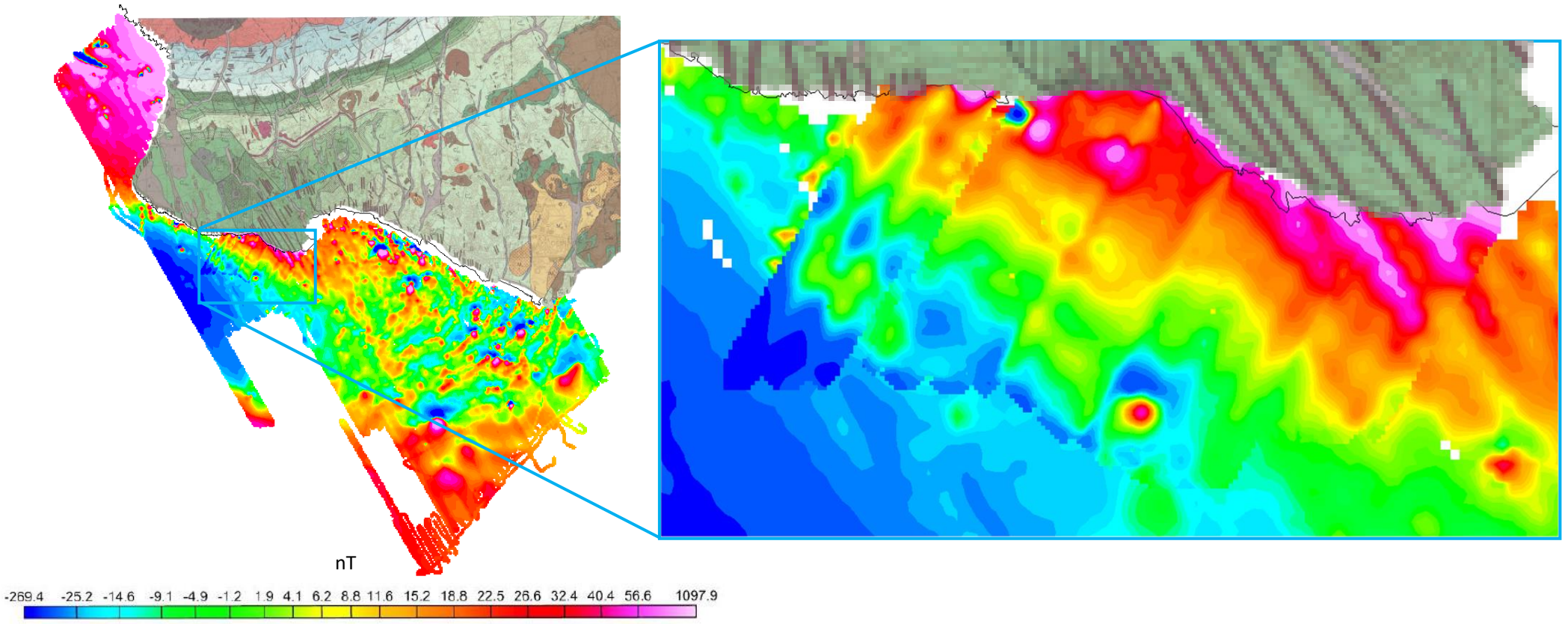
LP40_Leveled





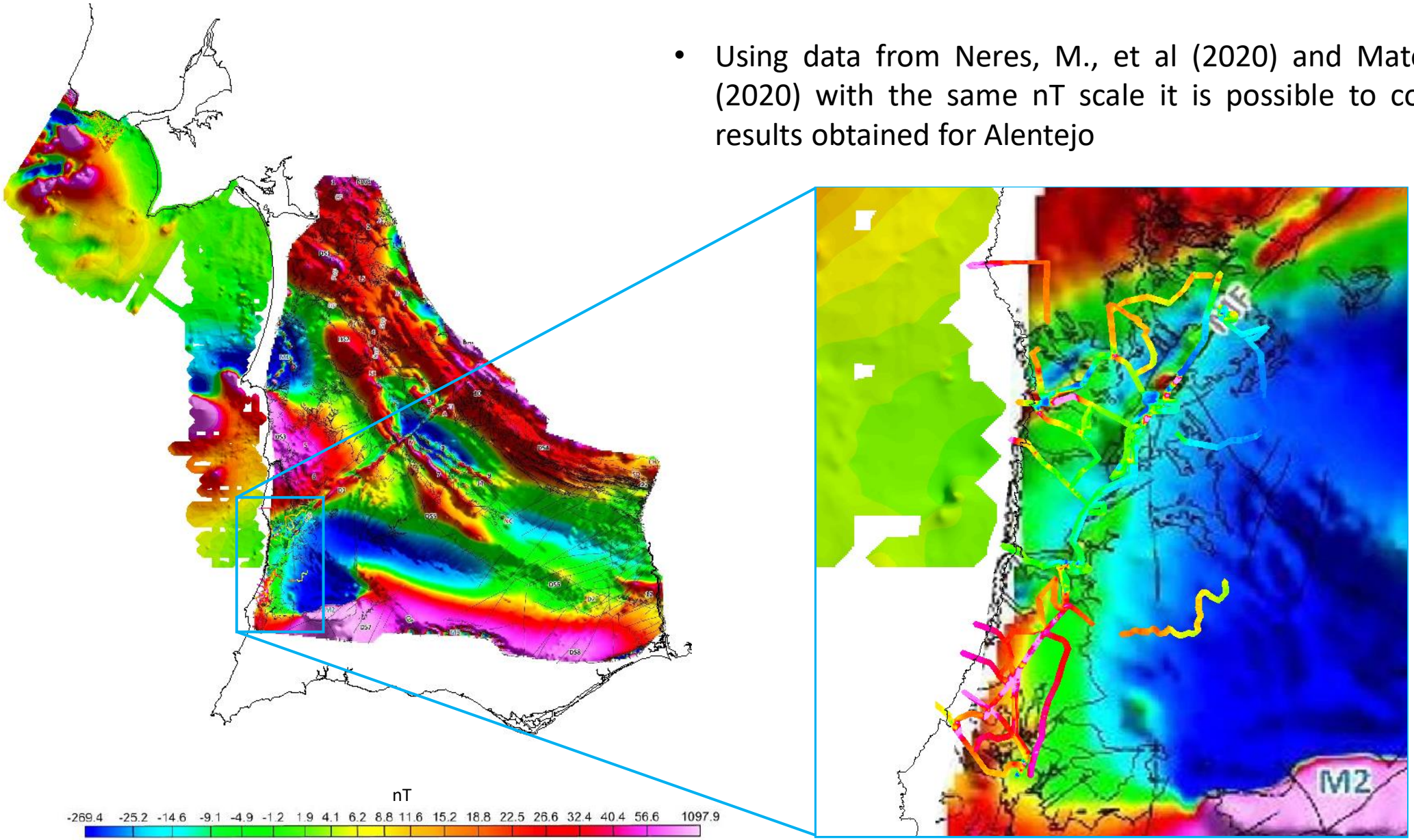
- The LP40 allows the signal to be smoother and reduce the noise
- The levelling reduce the amplitude gaps between close lines, which did not correspond to the real values

Results



- Cascais drone data fits the sea data correctly and provides more detailed information (higher resolution)
- Drone survey will allow magnetic mapping under the Quaternary dune field

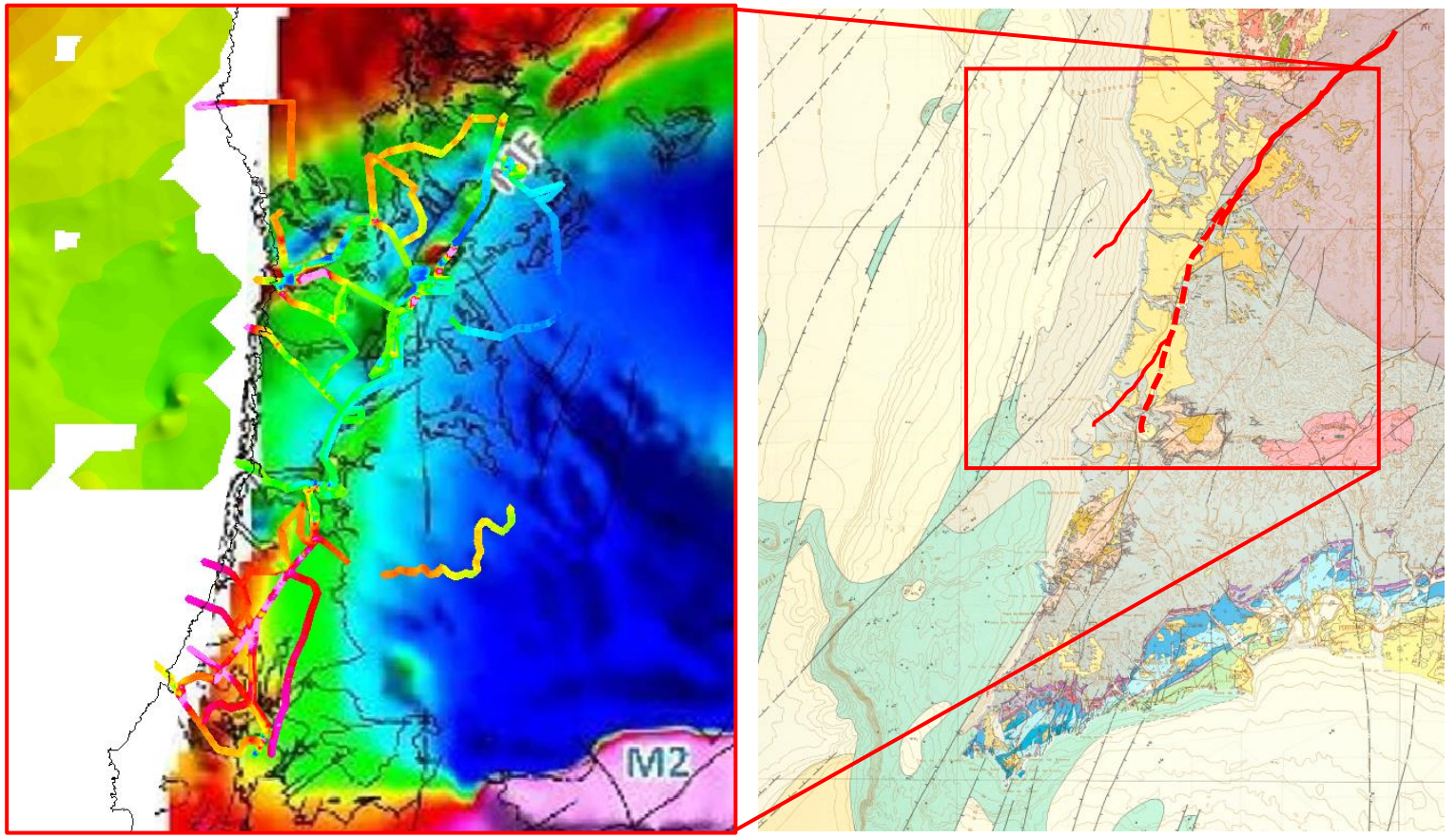
- Using data from Neres, M., et al (2020) and Matos, J. X., et al (2020) with the same nT scale it is possible to corroborate the results obtained for Alentejo



Conclusions

- MagDrone is a good tool for clarifying critical areas of magnetic surveys and map the sea-coast transition

- The identified positive anomalies suggest the main magnetic dyke splays into various dykes as the fault rotates its strike



- Further marine and drone magnetic surveys will be need to cover the full Messejana fault area

References

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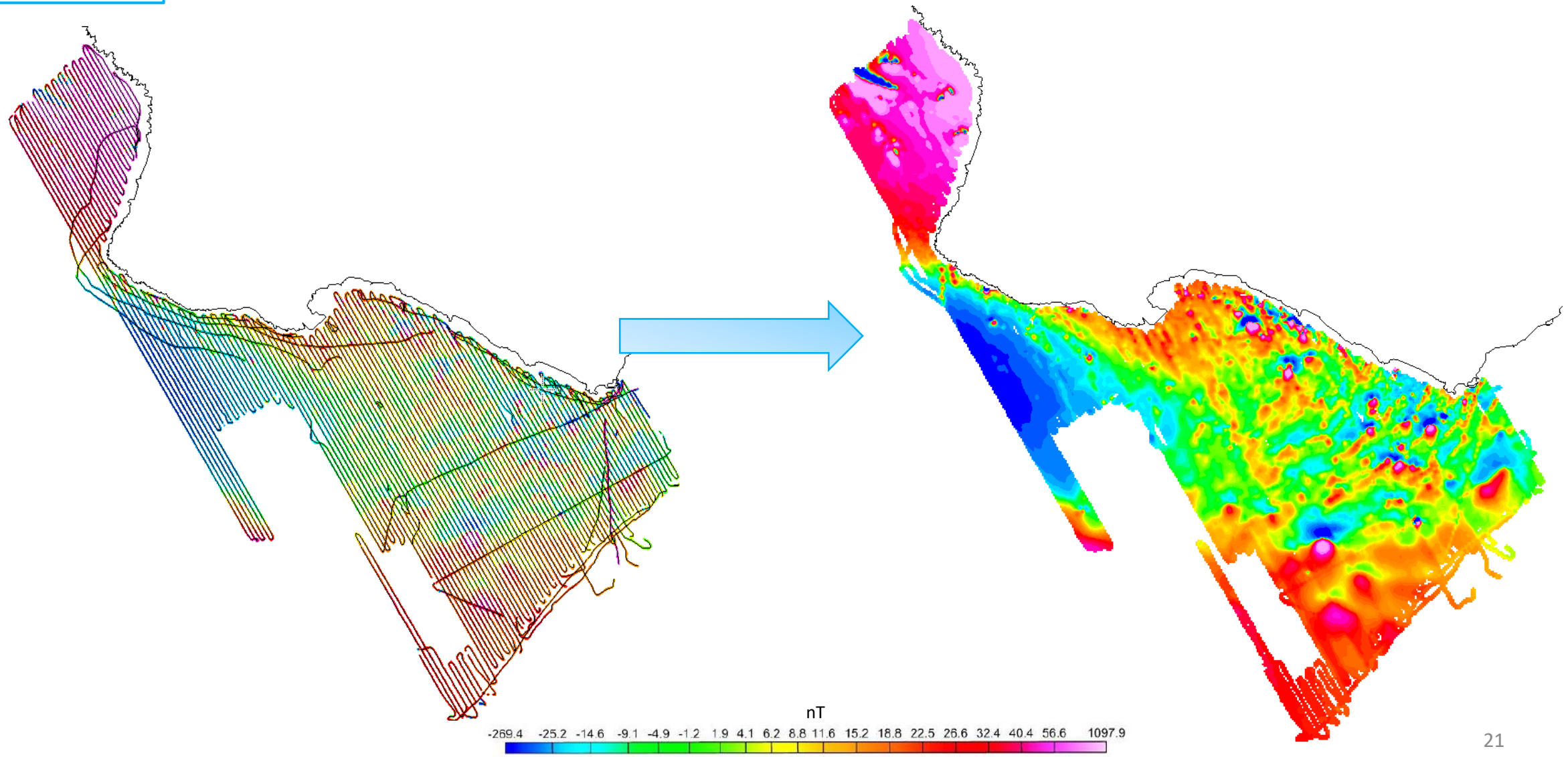
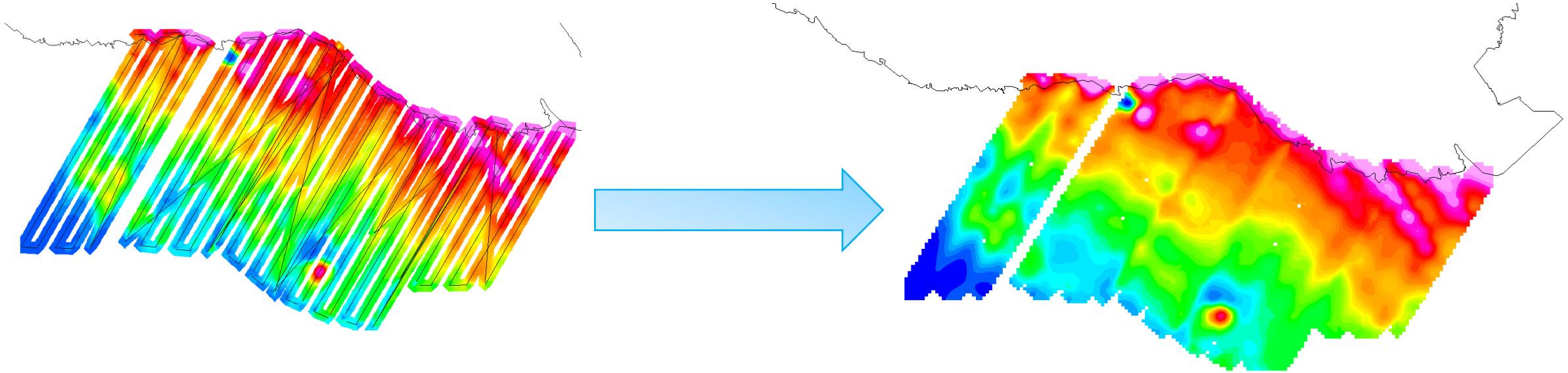
- De Vicente Muñoz, G., Olaiz Campos, A. J., Muñoz Martín, A., & Cunha, P. P. Longest and still longer: The Messejana-Plasencia dyke and its links with later Alpine deformation belt in Iberia. (2021)
- Matos, J. X., Carvalho, J., Represas, P., Batista, M. J., Sousa, P., Ramalho, E., ... & Dias, P. Geophysical surveys in the Portuguese sector of the Iberian Pyrite Belt: a global overview focused on the massive sulphide exploration and geologic interpretation. Comunicações Geológicas, 107(Fascículo especial III), 41-78. (2020)
- Neres, M., Terrinha, P., Brito, P., Rosa, M., Noiva, J., Magalhães, V., Silva, M., Teixeira, M., Batista, L. and Ribeiro, C. High-Resolution Marine Magnetic Mapping of the Portuguese Nearshore: Unraveling Geological Domains, Faults and Magmatic Structures. In AGU Fall Meeting Abstracts (Vol. 2020, pp. GP012-0005). (2020)

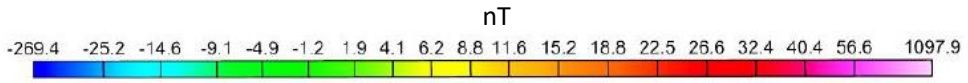
Appendixes

Cascais sea



Cascais drone





Alentejo drone