Novatem G2 versus Drone measurements

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For about ten years, Novatem Inc. of Canada has been developing a new miniaturized geophysical measurement system in order to take advantage of recent technological advances made by the drone industry. The specifications required both miniaturization and very low power consumption in order to be able to adapt to existing drone systems. It quickly became apparent that the use of drones was limited to small-scale studies due to the intrinsic limitations of drones available at a competitive cost with pre-existing airborne systems. The vast majority of helicopter surveys carried out in Canada for the mining industry is located very far from infrastructure and therefore requires a minimum of 2, ideally 3, hours of autonomy. Drones capable of carrying out this type of operation also require case-by-case authorizations that are not necessary for a commercial helicopter. The operating costs of long-range drones are also prohibitive compared to traditional helicopter surveys. The miniaturized system was therefore initially carried by a short-range drone (less than 45 minutes of flight). Since the device was fully autonomous, a commercial drone could be used. After a test campaign in spring 2019, the first commercial surveys began in summer 2019. The largest campaign was carried out for the Ministry of Energy and Natural Resources of Quebec (MERN). The surveys found 100% of the wellheads of old drillings whose location was unknown, plus other drilling wells that were not listed. The resolution of the measurements obtained with the new system was unprecedented, so that a significant demand for larger surveys emerged as soon as the first results were presented. After several studies on the specifications and costs of available longer-range drones, it appeared that a light helicopter would fully meet all the requirements, mainly autonomy, operating cost and ease of operation, without the drawbacks of drones with a similar autonomy (more than 4 hours of flight). Modifications were made to the helicopter to meet all noise requirements and a Supplemental Type Certificate was finally issued by Transport Canada to Novatem Inc. in May 2020. After several demonstration campaigns to its customers in Quebec, Ontario and Saskatchewan, Novatem has thus carried out more than 300,000 km of surveys for mining companies over the last 3 years. The results and the low acquisition cost led to the extension of most of the studies initially envisaged.

In this presentation, we compare the results of two surveys carried out successively using a drone and then using Novatem's G2 light helicopter. Since the survey was carried out in a very short time and along continuous flight lines, very little processing is required. The flight days are carefully chosen during periods of magnetic quiet in order to minimize processing and ensure the quality of the final data. In this way, no filtering is applied to the data during processing. Corrections for variations in the external magnetic field are done simply by leveling and not by subtracting the data from the base station as is usually done. In this way, no entropic noise or external pulsation that does not exist in the flight data affects the final data.

Novatem carried out this survey near Lebel-Sur-Quévillon, in northern Quebec, Canada. Part of this survey had already been flown using a drone, with exactly the same acquisition parameters: Line spacing = 50 m; Tie-line spacing = 500 m; Line direction = N45.

The following two figures represent the final data from these two surveys, using exactly the same grid and mapping parameters. Figure 1 represents the survey carried out using the drone and Figure 2 the survey carried out using the Novatem G2 system.

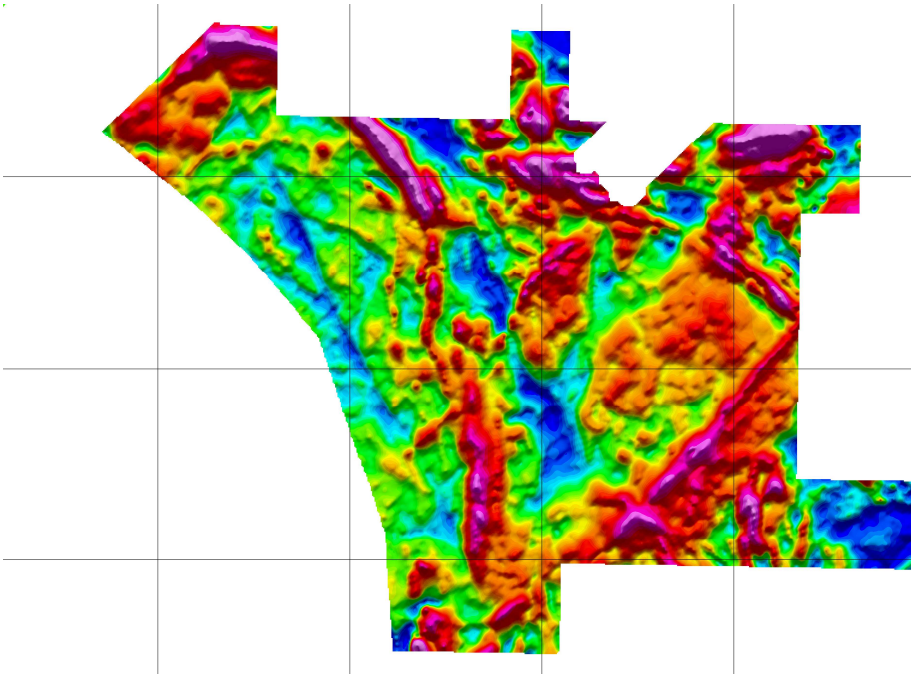

Figure 1: Anomalies of the Total Magnetic Field Intensity, carried out using a Drone

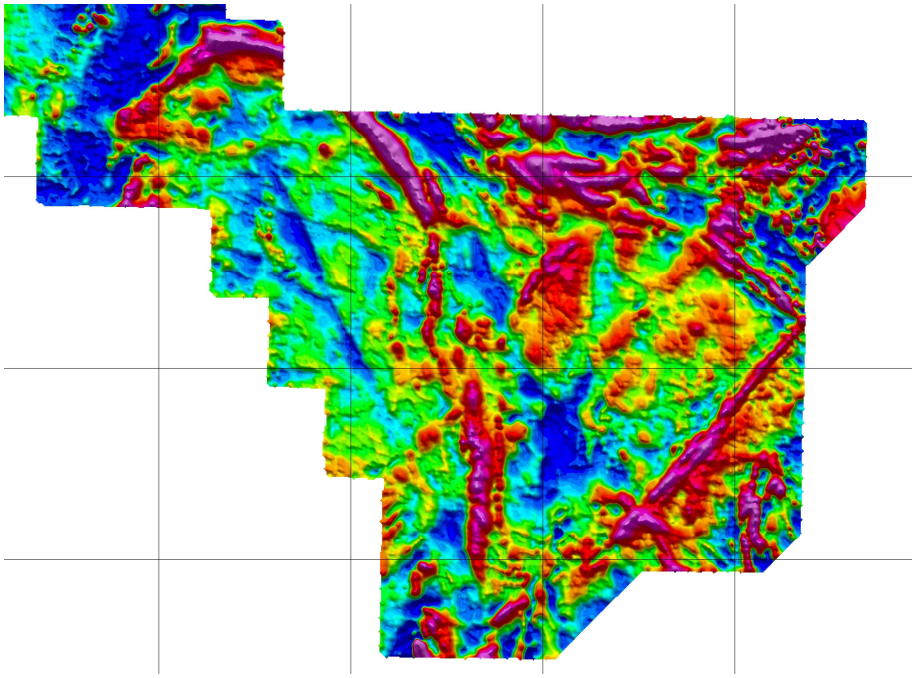

Figure 2: Anomalies of the Total Magnetic Field Intensity, carried out using Novatem G2

The most notable differences between the two acquisition systems are summarized in the following synopsis and comparative table:

DRONE	NOVATEM G2
• Lowest resolution • Resolution varies greatly sign of significant height variations • Strong corrugation • Low drone autonomy: 30 to 45 minutes, rarely more • The survey therefore requires a lot of time to be completed • Given the low autonomy of the drone, the team must get as close as possible to the block, by snowmobile, all-terrain amphibious vehicle or helicopter! • To make travel more profitable, once in the field, the survey is often flown regardless of the level of magnetic agitation • The swing of the drone, the bird and the magnetometer in the wind and the effect of variations in acceleration, generate significant magnetic noise requiring sometimes dramatic filtering for resolution	• Highest resolution • The resolution is uniform as the survey is flown at a constant height • No corrugation • More than 4 hours of autonomy • The survey is carried out very quickly • Given the very long autonomy of the G2, ferries, even large ones, are flown very easily, in a straight line and therefore very quickly • Given the ease of flying the block, flight periods are carefully chosen, outside periods of magnetic agitation • The aerodynamics and speed of the Novatem G2 helicopter give it very high stability in flight resulting in a very low noise level.

As the drone has autonomy of 30 to 45 minutes, rarely more, it must return regularly to its base. The survey is therefore generally done in small blocks, in the form of a mosaic. For this survey, long lines have been flown, but with very significant variations in height above the ground. Hence the resolution varies enormously. On the east of the survey for example, the drone was never able to descend in the valley resulting in lower resolution.

As the drone does not follow a draped surface, the regular lines and the control lines (tie-lines) cannot intersect at the same height and therefore the leveling is not done correctly resulting in a significant corrugation, mainly on the western part of the map where topographic variations are significant.

As the sensor is subject to permanent variations in acceleration due to wind and trajectory variations, variations in pitch, roll and yaw are significant, resulting in a high noise level. To correct this very high noise level, severe filtering is applied resulting in a dramatic loss of resolution.

Following is the topographic map of the block to help better understand the drone height variations, both on the western part of the survey (topographic highs) and on the eastern part (steep slopes, with a lake at the bottom of the valley).

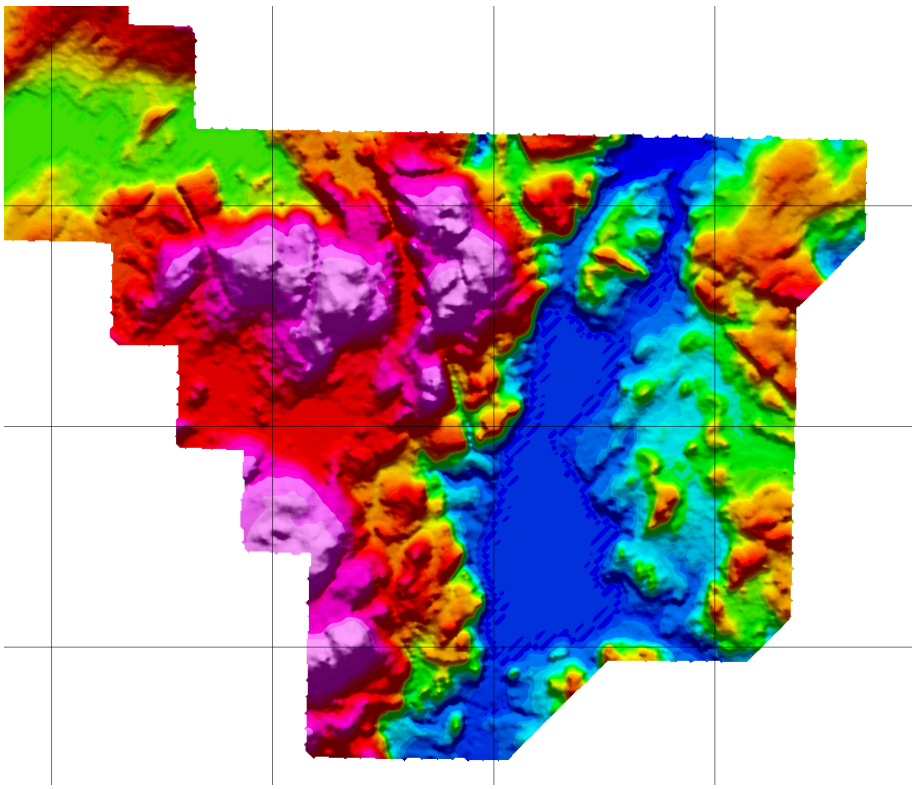

Figure 3: Elevation map using the Novatem G2 laser height measurements