

# Geophysical prospection and rescue archaeological excavation of subsurface WWII remains in the foreland of brown coal mines in northwestern Bohemia

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## INTRODUCTION

Geophysical methods have been used to survey the foreland of northern Bohemian brown coal mines for several decades, monitoring several dozens of sites, verifying by archaeological excavation and subsequently mining. Preliminary geophysical surveys contributed to the identification and efficient investigation of various prehistoric, early medieval, medieval and also modern settlements, burial grounds, various enclosed production and other areas (Křivánek 1999; 2001). Current archaeological research in the foreland of the Bílina mine, cadastre Libkovice, district Most, is aimed at uncovering remains of wartime activities from World War II. Magnetic prospection seemed to be a very useful geophysical method for monitoring former fields in the foreland of the mine, identifying subsurface relics of air defence units and other buildings and ancillary facilities.

## HISTORY OF THE SITE AND ITS IDENTIFICATION

The air defence system east of Most city (German Sudetenland during WWII) was built in 1944, in the context of the extensive defences of the fuel-producing factory STW in Záluží near Litvínov. Anti-aircraft artillery emplacements were built in a number of strategic locations in the surrounding lowlands and in several places in the Ore Mountains. However, the Luftwaffe archive with written

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Fig. 1. Example of old aerial images from 1947 with visible soil marks of remains of anti-aircraft defences from World War II (source: Bílina mine)

sources, plans and documentation of the air defences was destroyed in Cheb in 1945. In 1944–45, the factory and its defences were intensively and repeatedly bombed by US Air Force and RAF aircraft. In the years following the end of WWII, the air defence facilities were largely dismantled down to the ground. Remains of artillery defences near Libkovice were distinguished as individual crop marks in aerial photographs from 1947 (Fig. 1) and 1953. Subsequent aerial photographs have not been equally distinct owing to long-term agricultural land use. Planned brown coal mining investment in the region in 2011 necessitated an accurate identification of no longer visible situations from WWII with rapid subsequent rescue archaeological excavation.

#### SURVEY METHODS

Geophysical prospection (as well as archaeological excavation) of surface WWII relics no longer visible on the ground is not one of the usual applications of geophysical methods in Czech archaeology. With an abundance of metal items in the topsoil well established (by surface artifact collections and metal detector surveys), the actual possibilities of magnetometry had to be tested first in this case.

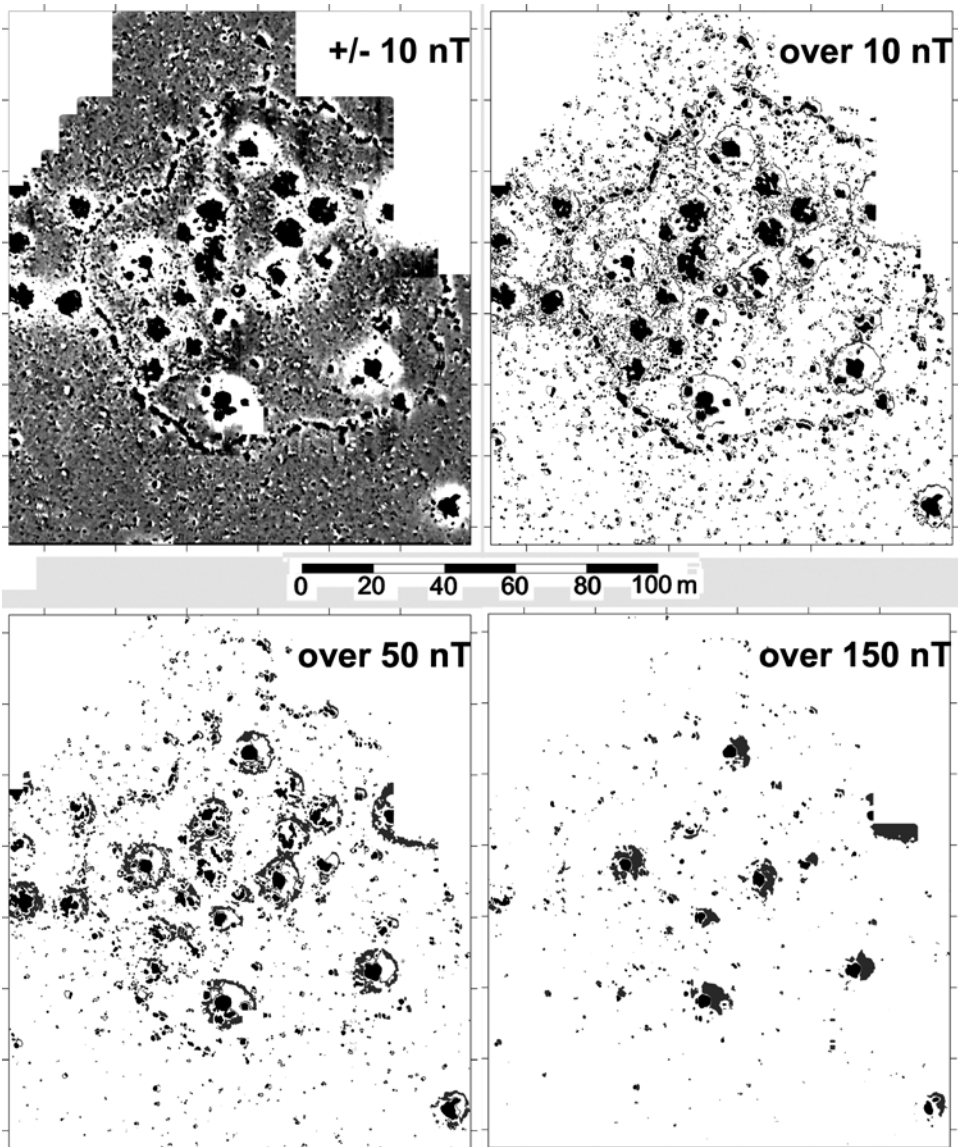


Fig. 2. Magnetic survey results on the spot of extinct anti-aircraft artillery (Flak no. 2) with separation of different amplitudes of high amplitude magnetic anomalies (presented area: approx. 1.35 ha; geophysical survey: R. Křivánek 2011)

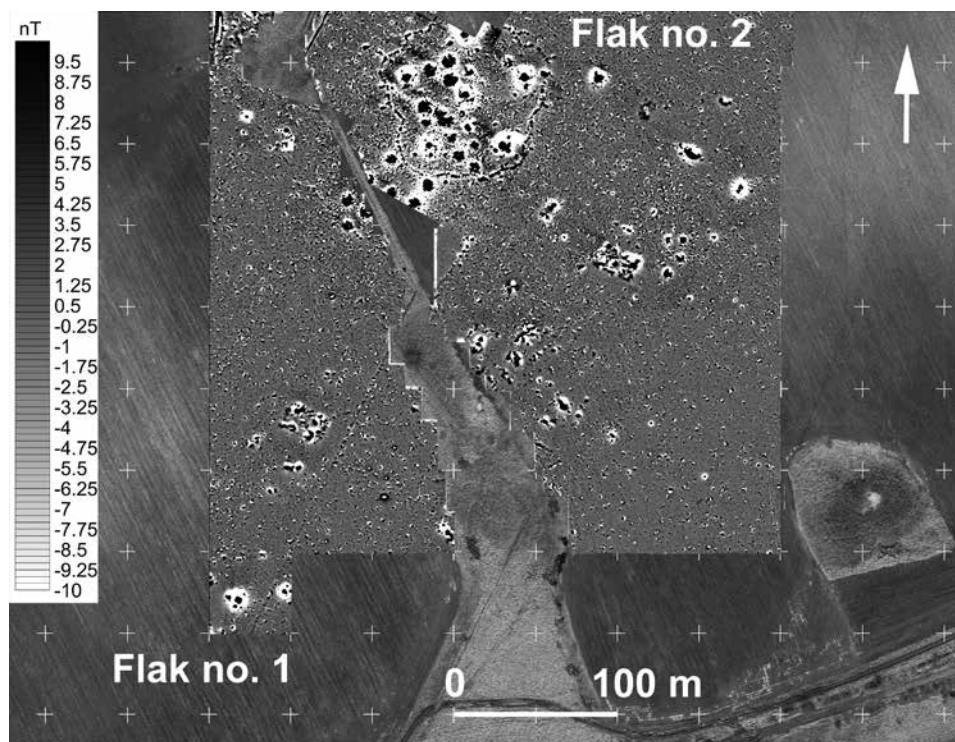


Fig. 3. Comparison of new aerial images and magnetic survey results (source: Bílina mine; presented area: approx. 11.3 ha; geophysical survey: R. Křivánek 2011–2014)

Despite the large number of smaller magnetic anomalies of different amplitudes, caused by minor metal objects (+/-1 to +/-10 nT), higher magnetic anomalies of larger metal components of military equipment and ammunition (common dipole anomalies from +/-10 to +/-100 nT) could be distinguished reliably in the results. A traditional field survey for sunken features with simple soil fill (not containing burned materials) would hardly be effective, but even despite the contamination, magnetic prospection was the optimal method for searching for various metal and military features over large areas of mine foreland. A five-channel Magneto-Arch magnetometer system with fluxgate gradiometers FMG-650B (Sensys) offered five parallel profile measurements with a data density  $0.5 \text{ m} \times 0.2 \text{ m}$  (testing with higher data density  $0.25 \text{ m} \times 0.1 \text{ m}$  did not produce better quality).

#### GEOPHYSICAL RESULTS

Magnetometric measurements in the foreland of the brown coal mines near Libkovice started in 2011, on the spot of a presumed anti-aircraft artillery emplacement (Flak no. 2). It proved possible to trace a nearly complete pentagonal ground plan of subsurface metal remains in the emplacement (Fig. 2). The highest dipole magnetic anomalies in the corners of the pentagon and in the centre

identified sunken cannon positions. Isometric and oval magnetic anomalies of larger diameter and lower amplitudes inside the anti-aircraft defences and in the vicinity were identified as probable pits left by bombardment. Other subrectangular to oval magnetic anomalies, identified over a wider area, probably signified relics and other objects and scattered metals. Continued magnetic measurements in a broader zone around the investigated Flak no. 2 artillery gun distinguished other clusters of magnetic anomalies, showing the presence of other emplacements and ancillary facilities outside of the firing position. The total surveyed area around Flak no. 2 on the Libkovice cadaster plan is now 12.36 ha; other areas in the vicinity have been prospected as well.

## ARCHAEOLOGICAL RESULTS

Intensive archaeological excavation of the area of Flak no. 2 has been conducted since 2013 (Čech *et al.* 2014). It enjoined cooperation with the Bílina mine and pyrotechnic experts from the Czech police and army in view of the threat of finding munitions. All five places in the corners of the pentagon and a sixth in the middle were identified in excavation, the latter as a sunken emplacement of the original anti-aircraft cannons with ferroconcrete base preserved at the bottom. Ancillary facilities were uncovered near the emplacements, including standby ammunition depots (with unexploded ammunition also) and an electrical installation in a brick channel. An electric generator and other remains of ammunition were also identified around the gun emplacement. In the case of larger isometric magnetic anomalies (with high magnetic inhomogeneous centres), the archaeological results changed a preliminary archaeo-geophysical interpretation. These were not pits left by the bombardment in 1944–45, but rather uncovered blasting pits used for the disposal of various types of ammunition after the end of World War II.

## CONCLUSION

Archaeological investigation with important parallel work by pyrotechnic experts will be continued in the area of Flak no. 2 in 2015. More than 4.5 tons of active ammunition have been uncovered in the last two years. The total weight of collected metal remains was over 12 tons and artifacts of diverse other materials were also discovered. Moreover, magnetometry, subsequently verified by excavation, has brought results concerning layers underlying the heavily contaminated surface. Old aerial photographs and prospection in the field has also made it clear that similar forgotten places of anti-aircraft defence from World War II can be expected in the Libkovice region (for example, Flak no. 1 in Figs 1 and 3). A broad-scale magnetic survey will continue to precede brown coal mining in the region. The present results of the efficient conjoint use of different methods have shown that this is (and must be) an urgent issue not only for archaeology and for the brown coal mine industry, but also for pyrotechnic experts, police and specialists from military history institutes and museums.

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