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Use of the Ott's system of coordinate for the protection of buildings and people in the Ostrava-Karvina Coal District

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ABSTRACT

The aim of this article is to determine the coordinates of the points of Ott's Coordinate System in contemporary obligatory reference coordinate systems, which means the coordinate system of Datum of Uniform Trigonometric Cadastral Network. Optimal transformation relations have been searched in such a way, so as not to disturb the accuracy of calculations and measurements acquired in Ott's triangulation. Ott's system of coordinates was and is hugely important particularly during the remediation works performed between 1996 and 1998, aimed at removing the consequences of coal mining in the Ostrava-Karviná Coal District.

1. Introduction

The mine-district system of coordinates for mines located in the Ostrava Region was established in 1858 by Ing. František Ott, Surveyor of the Emperor Ferdinand Northern Railway (Severní dráha Ferdinandova), who carried out mine triangulation within the western part of the Ostrava-Karviná Coal District.

The coordinate axes of Ott's coordinate system were parallel to the axes of the Austrian St. Stephen Datum of Cadastre Coordinates valid for the territories of Lower Austria, Moravia, Silesia and Dalmatia. Due to a reliance on using compasses, the choice of coordinate axes adapted to mine mapping habits; thus the positive x-axis pointed to the north and the positive y-axis pointed to the east.

When calculating the surface area of mining fields displayed as units, corrections from cartographic distortion in lengths or angles were not applied due to the small areas being studied. The values which held a great level of interest for mine surveyors included the convergence of meridians, magnetic declination and the convergence of medians. A reference to Ott's study is used in a book written in Kurrent, a German neo-Gothic script, dating back to the period between 1870 and 1880, which contains calculations and coordinates of all mine shafts and mine outlets in Ott's system of coordinates.

In some mines in the Ostrava-Karviná Coal District, the Ott system of coordinates was still in use up until the 1970s; even today, its practical value lies in its ability to trace and liquidate old mine outlets or test and survey prospective shafts with the use of this system.

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2. Methods

2.1. Ott's triangulation

In order to achieve a reliable connection in mine surveying operations and due to the large area of mining fields per square mile, the method of triangulation was used for all surveys of the mining fields in the Ostrava Coal District in Ott's system. In light of the planned opening of mining fields, trigonometric networks were set up and their vertex points were located at elevated points where possible.

When using triangulation, it is first necessary to measure the exact length of at least one side of the trigonometric network triangle. The length of all sides of the trigonometric network triangle can then be derive from this length and the angles measured. If the trigonometric network covers a large area, it is necessary to select and measure the exact lengths of more than one side. Due to the long lengths of the trigonometric sides, this issue is usually solved by using a "geodetic base line" which is shorter and enables the calculation of the length of the first trigonometric side based on the measured angles and lengths.

The Emperor Ferdinand Northern Railway was selected to act as base line A in Ott's trigonometric network. The direction of the base line was set in parallel with this railway, 3.66 feet (1.156 m) from the main yard. The start point of base line A was set to the east of Ostrava's main railway station and it was stabilized using the aforementioned method of stabilization of trigonometric points. The direction of the base line was set by the Breithaupt theodolite. The intermediate points of the base line were set up within a distance of approximately 30 fathoms (56.89 m) by means of poles into which nails had been driven. The terminal point of the base line was situated at the Hrušov railway station.

The second base line (baseline B) was situated in Michálkovice, and it measured 103.251 fathoms (195.813 m). It was considered a control base line for the measurements carried out in the trigonometric network. Both base lines were measured repeatedly. The general principles of the creation and measurement of base lines are described in Ott (1859).

2.2. Ott's system of coordinates

The X-axis of Ott's system of coordinates was set in accordance with the third sheet line of the east column XIX to the west (dc) and the Y-axis in accordance with the fourth sheet line of the 9th layer to the south (hi) of the S-SK system (see Fig. 1). The intersection point of the said column and layer is the origin of the Ott system of coordinates and is marked on the map of the triangulation network as a red point. The origin was situated in the municipality of Zámost, 240 fathoms to the north of Josef-Schachte (Mine Joseph) and 50 fathoms to the east of Rothschild's Uhelná Street leading to Hrušov.

Ott's system of coordinates was connected to the St. Stephen Datum of Cadastre Coordinates by surveying the points from the second order cadastral triangulation in the territory of the "Ostrava Region", where two geometricians, Ploebst and Schmitt, worked between 1822 and 1824. These points were the churches (church towers) in the municipalities of Vratimov (Ratimow), Hošťálkovice (Hostialkowitz) and Vrbice (Wirbitz). At present, the coordinates of these points in fathoms can be found in the Central Archives of Surveying and Land Register (CASLR), namely in volume A2/b/S4 titled "Determination of triangulation results and topographical descriptions of trigonometric points" (1821–1829).

The church towers were surveyed from point F (see Fig. 2), which belonged to Ott's system of coordinates, and was situated on an old spoil tip in Muglinov. Its coordinates were determined by the resection method and served as the basis for deriving the azimuths of individual sides of triangles and for calculating the coordinates of individual points.

The X-axis of the Ott system of coordinates was parallel to the X-axis of the datum of the stable cadastre system passing through the main tower of St. Stephen's Cathedral in Vienna. The relationship between Ott's system of coordinates and the St. Stephen Datum of Cadastre Coordinates is determined by linear transformation:

$$y = y_0 + Y' \cos\psi + X' \sin\psi, \quad x = x_0 + X' \cos\psi - Y' \sin\psi, \qquad (1)$$

where $y_0 = -138.443.332$ m, $x_0 = -183.579.651$ m are the coordinates of the origin of the Ott's system in S-SK, Y′, X′ are the coordinates in the St. Stephen Datum and $\psi = 180^\circ$ is the angle between Ott's coordinate system meridian and the meridian of the St. Stephen Datum.

2.3. Significance of the Ott system of coordinates in the past and at present

Ott's triangulation was important for the accurate determination of the position of mining fields granted by the state as a lease. This was done by surveying the boundary markers of mining fields and calculating their coordinates, which were then used as the basis for the calculation of other corner markers of mining claims and surpluses based on the lengths and directions defined in the demarcation records. A mining claim (Section 42, 46 in (Emperor's Patent, 1854)) was an area in the shape of a rectangle with an area of 45.116 m^2 on the horizontal level of the gauge point. The gauge point (Section 45 in (Emperor's Patent, 1854)) was a point from which the mining claim was measured and it had to be situated in an opened part of the deposit inside the mining field that was to be granted as a lease (a mining lease was the right to extract reserved minerals). Within one year of the date of the lease, each leased mining field had to be surveyed and landmarked on the surface in accordance with the lease certificate and the map showing the mining claims. The land-marking conducted was recorded in the demarcation record in which each landmark position was described and plotted on the map of mining claims (Section 50 in (Emperor's Patent, 1854)). A surplus (Section 71 in (Emperor's Patent, 1854)) was an area locked by mining claims, in which it was no longer possible to place a whole mining claim. In the case of new leases, the corner markers of mining fields were determined in coordinates which helped eliminate the lengthy process of determining the leased mining fields pursuant to Sections 64–66 (Emperor's Patent, 1854). The demarcation lines, which defined the boundaries of coalfaces belonging to different