

THE CZECH REPUBLIC

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Once part of the Holy Roman Empire, the first Czechoslovakian Republic (1918-1939) was formed by Czechs and Slovaks from territories that were formerly part of the Austro-Hungarian Empire. Those provinces were Bohemia, Moravia, Silesia and the northern part of Hungary settled by Slovaks and Ruthemians (Slovakia and Carpatho-Ukraine). Hitler supported the ethnic Germans living in the Sudeten region as an excuse to the German annexation, which reduced it to the Protectorate of Bohemia and Moravia (1939-1945). The remaining portions of the republic were broken up among neighboring countries during WWII. After the war, it emerged as the Second Czechoslovakian Republic, but without the Carpatho-Ukraine. The USSR gained control, and Czechoslovakia became part of the Warsaw Pact in 1955. Consequently, in discussing the surveying and mapping of this country, a differentiation is made with respect to the activities of four separate epochs, *i.e.* the First Czechoslovakian Republic, the Protectorate, the Second Czechoslovakian Republic, and the Czech Republic. On 1 January 1993, the country peacefully split into its two ethnic components, the Czech Republic and Slovakia.

The Czech Republic is north of the Danube Valley and is largely mountainous. Bohemia, in the west, consists of rolling plains, hills, and plateaus surrounded by low mountains; Moravia, in the east, consists of very hilly country. The lowest point of the republic is along the Elbe River (115 meters), and the highest point is Snezka (1,602

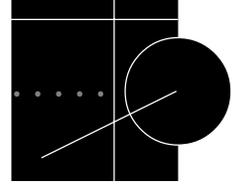
meters) in the Carpathian Mountains.

The original triangulation of the region by first-order methods was by the III K. und k. military triangulation of the Austro-Hungarian Empire. The cadastral grids employed by the Hapsburgs were the Böhmen Soldner (Cassini-Soldner) with a $\phi_0 = 48^\circ 02' 20.5''$ N, $\lambda_0 = 14^\circ 08' 24.15''$ East of Greenwich, and the Mähren Soldner with a $\phi_0 = 48^\circ 12' 32.75''$ N, $\lambda_0 = 16^\circ 22' 36.58''$ East of Greenwich. No false origins were used according to the European convention of the time. However, the entire region was not covered by 1918 as published in the *Ergebnisse der Triangulierungen* (Triangulation Results). The responsibility for the survey activities in the First Republic was divided among the following agencies: *Triangulační Kancelář Ministerstva Financi* (Triangulation Office of the Ministry of Finance); *Katastrální Měřické Úřady* (Office of Cadaster); *Nivelacní Úřad Ministerstva Veřejných Prací* (Leveling Office of the Ministry of Public Works); and *Vojenský Semepisný Ústav* (Military Geographic Institute). The duties of the civilian agencies had some overlap among themselves as well as with the military, but the records of all agencies could be utilized for military purposes. The territory was covered by the old cadastral triangulations with origins at Gusterberg, St. Stephan Tower (Vienna), Gellertheyg, Pschow, and coordinates referring to Vienna University Datum, St. Anna Datum, and Hermannskogel Datum. A new first-order net was started in 1936 and was completed in 1956. The basic cadastral trigonometric net was connected with the first-order nets of Austria, Germany, Poland, and Romania (through the

Carpatho-Ukraine and Slovakia). Between 1918 and 1932, the Military Geographic Institute (MGI) applied the Lambert conformal conic projection for triangulation computations and mapping. This was based on the Hermannskogel Datum of 1871 referenced to the Bessel 1841 ellipsoid of revolution where the semi-major axis (a) = 6,377,397.155 meters and the reciprocal of flattening (1/f) = 299.1528128. The Hermannskogel 1871 Datum has its origin with $\phi_0 = 48^\circ 16' 15.29''$ N, $\lambda_0 = 33^\circ 57' 41.06''$ Est de l'Île de Fer (East of Ferro Island in the Canaries), where Ferro = $17^\circ 39' 46.02''$ East of Greenwich and azimuth to station Hundsheimer is $\alpha_0 = 107^\circ 31' 41.7''$. The secant Lambert Grid had the standard parallels of $\phi_N = 50^\circ 15' N$ and $\phi_S = 48^\circ 30' N$, a Central Meridian (λ_0) = $35^\circ 45'$ East of Ferro, a False Easting = 1,000 km, and a False Northing = 500 km. This point corresponds to the center of the southern sheet line of the 1:75,000 sheet titled "4260 Vsetin."

Professor Ing. Josef Krůvák (commonly spelled Křovák or Krovák) prepared the Conformal Oblique Conic Projection of Czechoslovakia in 1922 for the preparation of cadastral (tax) maps and topographic maps of medium scales for the civil geodetic service of Czechoslovakia. The "starting meridian" was termed Ferro where the MGI usage differed from the civilian definition listed above. The MGI used the relation: Ferro = $17^\circ 39' 45.90''$ East of Greenwich. The Krovák Projection is a double projection in that the oblique conic is projected from the Gaussian Sphere where the radius = 6,380,703.6105 meters. The Gaussian Sphere was "invented" by Carl Friederich Gauss, and is also commonly known as the "conformal sphere." It is simply

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the geometric mean of the ellipsoidal normal (at a point) terminated by the semi-minor axis and the radius of the ellipsoid (at the same point) in the plane of the meridian. To be succinct, it's $[\nu\rho]^{-1/2}$ evaluated in this case at $\phi = 49^\circ 30' N$. For the Mapping Scientists and Photogrammetrists that do not live in South Louisiana, this is the same formula used in the commonly used radius of the earth for the "sea-level correction" in establishing ground control. For the Czech Republic, they used the Bessel 1841 ellipsoid at that latitude. Whenever one sees the term "double projection," the generating sphere is usually the Gaussian Sphere. The oblique cone has a pole centered at $\phi_{\square} = 59^\circ 42' 42.6969'' N$, $\lambda_{\square} = 42^\circ 30' \text{ East of Ferro (southwest of Helsinki, Finland)}$. The spherical cartographic coordinates are transformed into the rectangular plane coordinates of the uniform cadastral system. For this purpose the reduced (0.9999) Gaussian Sphere is projected on the surface of an oblique cone touching the sphere around the central cartographic parallel, having a cartographic latitude of $78^\circ 30' N$, with the vertex in the extended axis connecting the center of the sphere at the rotation angle of $30^\circ 17' 17.3031''$. This is still in use as of 2000, and is known as Systém - Jednotné Trigonometrické Síti Katastrální or S-JTSK (System of the Unified Czech/Slovak Trigonometrical Cadastral Net). The Czechs state (Prof. Ing. Bohuslav Veverka, DrSc., Prague, November 1997) that the "scale, location and orientation of the S-JTSK on the surface of the Bessel's ellipsoid was derived from the results of the historical Austro/Hungarian military surveys in the years 1862-98. There are 42 identical points on the Czech territory used for transformation computations. Astronomical orientation was measured only on the Hermannsko-gel trigonometrical point in Austria,

scale factor was derived from the basis of the geodetic length in Josefov." Professor Veverka published a program written in the Pascal language that performs the direct and inverse transformations with the Krovak Projection. Note that the **X**-axis normally coincides with the meridian $42^\circ 30' \text{ East of Ferro}$ increasing **South**, and the orthogonal **Y**-axis is increasing **West**. A test point provided lists: $\phi = 48^\circ 07' 46.2973$, $\lambda_{\square} = 35^\circ 42' 35.2147''$, $Y = 504,691.675 \text{ m}$, $X = 1,289,068.724 \text{ m}$. The Krovak Projection was officially adopted by the Czech military in 1932.

In 1939, the Germans found that during their occupation of the "Protectorate of Bohemia and Moravia," only 5% of the Protectorate's territory was covered by the new topographic survey. The Landesvermessungsamt Böhmen und Mähren (Land Survey of Bohemia and Moravia) was formed. The subsequent triangulation was incorporated into the final Reichsdreiecksnetz (Triangulation Net of the Empire), with the datum origin being at Potsdam where $\Phi_0 = 52^\circ 22' 53.9540'' \text{ North}$, $\Lambda_0 = 13^\circ 04' 01.1527'' \text{ East of Greenwich}$. The defining azimuth to station Golmberg is: $\alpha_0 = 154^\circ 47' 32.19''$, and the ellipsoid of reference is the Bessel 1841. For the purpose of incorporation, the Reichsdreiecksnetz was extended over the territory of the Protectorate, and 36 first-order stations were re-observed with two new base lines measured at Poděbradý and Kroměříž. The Grid system used was the Deutsche Herres Gitter (DHG) which had the exact same parameters of the UTM Grid except that the scale factor at origin was unity. The DHG is exactly the same as the USSR's Grid (Russia Belts) except for the ellipsoid.

After WWII, the agencies responsible for geodetic, topographic and

cartographic activities in the Second Czechoslovakian Republic were in a stage of re-organization up to the end of 1953. During the years 1953-54, those agencies were subsequently organized according to the pattern established in the USSR. The Ústřední Správa Geodesie a Kartografie – USGK, (Central Administration of Geodesy and Cartography) was established. The Základní Trigonometrická síť – ZTS (Basic Trigonometric Net), included the first-order net of the Protectorate and the first-order net established in 1949-1955 in Slovakia. The adjustment of the net was carried out by the method of Praniš-Praniévitch on the Krassovsky 1940 ellipsoid where $a = 6,378,245$ meters, and $1/f = 298.3$. The Datum is defined as "System 42" where the origin is at Pulkovo Observatory: $\Phi_0 = 59^\circ 46' 18.55'' \text{ North}$, $\Lambda_0 = 30^\circ 19' 42.09'' \text{ East of Greenwich}$. The defining azimuth at the point of origin to Signal A is: $\alpha_0 = 317^\circ 02' 50.62''$. The "Russia Belts" Grid System is used with the System 42 Datum; identical to UTM except that the scale factor at origin is unity.

A civilian version used since 1952 is a modification of the Russia Belts system in that the False Northing at origin was $\phi = 49^\circ 30' \text{ North}$, the False Northing = 200 km, the False Easting = 500 km, and the scale factor at origin (m_0) = 0.99992001. Everything else remained the same as the standard Gauss-Krüger Transverse Mercator Grid. Boundary treaties with adjacent countries refer to ancient datums and grids that include the old double stereographic projections of the 19th and early 20th centuries. The S-JTSK Krovak Projection is alive and well in the Czech Republic for the 21st century.

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