

Republic of Austria

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On 1 November 996, an area of land popularly known as "Ostarrichi" was given by Emperor Otto the Third to the Bishop of Friesing as a gift. In 1156 the Privilegium Minus elevated Austria to the status of a Duchy. When of the Habsburg dynasty ascended to power, the lands of Vorarlberg were added, with Bohemia and Hungary added as provinces to their holdings. These acquisitions, completed under the Habsburg rule, were the foundation for the country of Austria as it appears today. After the crowning of Maria Theresa as Queen of Bohemia in 1743, her husband Franz was elected Holy Roman Emperor in 1745. As a measure of standing to other royal courts, Queen-Empress Maria Theresa ordered a survey of all of the Hapsburg holdings in 1763. This was the First Topographical Survey (Josephinische Aufnahme) of the Hapsburg provinces. The Liesganig triangulation and attached supplemental surveys were executed graphically with plane table and alidade. There was no geodetic survey used as a foundation. The associated topographic survey was performed at a scale of 1:28,800 and was based on the Vienna Klafter System where 1 Zoll = 400 Klafters = 758.6 meters. Altogether there were about 4,500 sheets surveyed and all of them were kept secret for military purposes. After completion of this first survey in 1787, Emperor Franz I declared Austria an Empire.

The second topographic survey of Austria (Franzische Aufnahme) was conducted from 1806 to 1869. The Vienna Datum of 1806 was established based on the origin of St. Stephan Turm (St. Stephan's Tower) where $\Phi_o = 48^\circ 12' 31.5277''$ North and $\Lambda_o = 16^\circ 22' 27.3275''$ East of Greenwich. (These longitudes were originally referenced to Ferro, in the Canary Islands, which is $17^\circ 39' 46.02''$ West of Greenwich.) The defining azimuth of the Datum was from St. Stephan Turm to Leopoldsberg: $\alpha_o = 345^\circ 55' 22.0''$. Coordinates for the mapping were based on five Cassini-Soldner Grids. For the provinces of Lower Austria the Vienna Grid was centered at the datum origin. The Gusterberg (Kremsmünster) Grid was for the provinces of Oberösterreich and Salzburg where $\phi_o = 48^\circ 02' 18.4753''$ N and $\lambda_o = 14^\circ 08' 15.0242''$ East of Greenwich; the Schöcklberg Grid (near Graz) was for the Prov-

ince of Steiermark where $\phi_o = 42^\circ 11' 54.8745''$ N, $\lambda_o = 15^\circ 27' 59.9472''$ East of Greenwich; the Krumberg (Laibach) Grid near Ljubljana was for the provinces of Carinthia, Carinola, and Littoral (now Italy) where $\phi_o = 45^\circ 55' 43.7228''$ N and $\lambda_o = 14^\circ 28' 18.8027''$ East of Greenwich; and the Innsbruck Grid, centered at the tower of the city-parish church (Pfarrturm), was for the provinces of Tyrol and Vorarlberg where $\phi_o = 47^\circ 16' 11.3060''$ N and $\lambda_o = 11^\circ 23' 39.3157''$ East of Greenwich. The Bohnenberger ellipsoid was used from 1810 to 1845 where $a = 6,376,602$ meters and $1/f = 324$. The Zach ellipsoid was used from 1845 to 1863 where $a = 6,376,602$ meters and $1/f = 324$. From 1847 to 1851 the Walbeck ellipsoid was also used where $a = 6,376,896$ meters and $1/f = 302.78$. Some small-scale derivative mapping was done on the Bonne projection. The main chains of the second military triangulation surveyed from 1806 to 1829 covered the western part of the Empire (west of the Budapest meridian) and the chain which extended along the Carpathian Mountains to Transylvania. The baselines used were at Wiener-Neustadt (1762), 6410.90 Klafters; at Wels (1806), 7904.045 Klafters ± 0.360 Klafters; at Raab (1810), 9429.429 Klafters ± 0.010 Klafters; and at Radovec (Radautz 1818), 5199.597 Klafters.

The third topographic survey of the Austro-Hungarian Empire (Neue Aufnahme) was conducted from 1869 to 1896 and was mainly based on the Vienna Datum and the Bessel 1841 ellipsoid (actually adopted in 1863) where $a = 6,377,397.15$ m and $1/f = 299.1528$. The Arad, St. Anna Datum of 1840, was initially used in Transylvanian surveys where $\Phi_o = 46^\circ 18' 47.63''$ North and $(\Lambda_o) = 39^\circ 06' 54.19''$ East of Ferro (geodetically determined from Vienna). This datum was referenced to the Zach ellipsoid and started in Transylvania and Tyrol. In 1872 the metric system was legally established in the Empire, and the scale of 1:25,000 finally adopted for topographic maps. The graticule sheet was adopted with the Polyhedric projection in order to eliminate inconsistencies in sheet lines and differences in the size and shape of sheet lines. The baselines used were at Arad, St. Anna, Hungary (1840), 8767.578 m; at Partin (Tarnow), Galicia

(1849), 5972.501 m; at Hall, Tyrol (1851), 5671.317 m; at Weiner Neustadt (1857), 9484.065 m; at Maribor, Styria (1860), 5697.405 m; at Josefov (Josefstadt) Bohemia (1862), 5257.266 m; and at Sinj, Dalmatia (1870), 2475.474 m. The Walbeck ellipsoid was used in computing the chains in Balicia and Bucovina so that ties could be made with the Russian triangulation.

The most common classical datum (prior to the European 1950) found in Austria and still used extensively is the Militärgeographisches Institut (Military Geographic Institute or MGI) Hermannskogel, *Habsburgwarte* 1871 Datum where $\Phi_o = 48^\circ 16' 15.29''$ N, $\Phi_o = 16^\circ 17' 41.06''$ East of Greenwich, and the azimuth to Hundsheimer is $\alpha_o = 107^\circ 31' 41.7''$. I developed the seven-parameter datum shift relation between Hermannskogel 1871 and ED 50 for Yugoslavia (*PE&RS*, September 1997), but most of the points were not in present Austria. The Austrian government has made transformation parameters available for "AT_MGI to ETRS89 (WGS 84) where $\Delta X = +577.3$ m, $\Delta Y = +90.1$ m, $\Delta Z = 463.9$ m, $\Delta s = 2.42$ ppm, $R_x = -5.137''$, $R_y = -1.474''$, and $R_z = -5.297''$. (The seven parameters are stated to be suitable "for applications with an accuracy of about 1.5 m). "The three-dimensional coordinates of (X,Y,Z) of AT_MGI were derived using ellipsoidal heights, which are computed from leveling heights related to Molo Sartorio (Trieste) and a Geoid related to AT_MGI Datum Hermannskogel and Josefstadt in Bohemia." Note that the signs of the rotations have been changed to conform to the United States standard convention as used and published by the NGA and by the NGS. The standard projection for civilian topographic mapping in the republic is the Gauss-Krüger Transverse Mercator where the belts are 3° wide such that, for Belt 3, $\lambda_o = 9^\circ$; the False Easting = 3,500 km; for Belt 4, $\lambda_o = 12^\circ$, the False Easting = 4,500 km; etc. There is no False Northing and the scale factor at origin, $m_o = 1.0$.

The military standard 1:50,000-scale topographic series of Austria is on the ED50 datum and the parameters published by the NGA from ED50 to WGS84 are $\Delta a = -251$, $\Delta f \times 10^4 = -0.14192702$, $\Delta X = -86 \text{ m} \pm 3 \text{ m}$, $\Delta Y = -98 \text{ m} \pm 8 \text{ m}$, and $\Delta Z = -121 \text{ m} \pm 5 \text{ m}$.

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Grids and Datums

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The Reader is cautioned that the above Austrian-government furnished seven parameters from Hermannskogel 1871 Datum to WGS 84 Datum may NOT be truncated to three parameters. Much of this was obtained from AMS Technical Report 25 by Andrew Glusic and from Suzanne Van Cooten's term paper in a graduate course she took from me years ago. I understand that it will soon be Dr. Van Cooten, according to her major professor at UNO.

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