# Grids & Datums

## Principality of Liechtenstein

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"The Liechtenstein family, of Austrian origin, acquired the fiefs of Vaduz and Schellenberg in 1699 and 1713 respectively, and gained the status of an independent principality of the Holy Roman Empire in 1719 under the name Liechtenstein. The French, under Napoleon, occupied the country for a few years. Napoleon was the founder of the Rhine Confederation in 1806 and accepted Liechtenstein as a member. Liechtenstein considers itself therefore to be a sovereign state since 1806. In 1815 within the new German Confederation, Liechtenstein could prove its independence once more. In 1868, after the German Confederation dissolved, Liechtenstein disbanded its army of 80 men and declared its permanent neutrality, which was declared during both world wars.

"In 1919, Liechtenstein and Switzerland concluded an agreement whereby Switzerland assumed representation of Liechtenstein's diplomatic and consular interests in countries where Switzerland maintains representation and Liechtenstein does not. According to an agreement concluded with Austria in 1979, Liechtenstein citizens may seek consular assistance from Austrian representatives abroad in countries in which neither Liechtenstein nor Switzerland maintain representation. After World War II, Liechtenstein became increasingly important as a financial center, resulting in more prosperity" (*U.S. Dept. of State Background Notes, 2011*).

About 0.9 times the size of Washington, D.C., the Principality of Liechtenstein is bordered by Austria (34.9 km) (*PE&RS*, March 2004) and by Switzerland (41.1 km) (*PE&RS*, August 2001). The lowest point is Ruggeller Riet (430 m) and the highest point is Vorder-Grauspitz (2,599 m). The terrain is mostly mountainous (Alps) with Rhine Valley in the western third. Complete topographic map coverage consists of 4 sheets at 1:10,000 scale. The *Fürstliche Regierung Liechtenstein* is responsible for all official mapping of the principality. The datum and grid is the Swiss Grid. "On the 1:10,000 maps, the north and west edges have the full grid values. The south and west edges have the grid values less the false coordinates, i.e. FE = 600 km, FN = 200 km" (*John W. Hager, 11 July 2001*). Dr. Christoph Brandenberger informed me that these false coordinates were originally from the Swiss military (Bonne Grid) and are now adopted for civilian use (*personal communication, January 2001*).

The Old Berne Observatory Datum of 1898 published an Astronomical Latitude ($\Phi_o$) = 46° 57' 08.66" N, based on observations executed by E. Plantamour in 1875 and a Astronomical Longitude ($\Lambda_o$) = 7° 26' 22.5" East of Greenwich. The defining azimuth to station Rötifluh was ($\alpha_o$) = 11° 12' 05.24". The ellipsoid height and deflection of the vertical are not defined and therefore are forced to zero at the origin. The reference ellipsoid is the Bessel 1841 where: a = 6,377,397.155 m, and $^1/_f$ = 299.15281285 (*op. cit., Brandenberger 2001*). For the Grid of the Swiss National Maps and of Liechtenstein, the value $\varphi_o$ = 46° 57' 07.90" N was chosen based on more recent measurements (1937), and the Central Meridian ($\lambda_o$) = 7° 26' 22.5" East of Greenwich. The radius of the Gaussian Sphere evaluated at the Grid origin for the Bessel 1841 ellipsoid is R = 6,378,815.9036 m. The Grid Scale Factor at Origin ($m_o$) = 1.00072913843, and the false origin is the same as for the old Swiss Bonne Grid of 600 km and 200 km. Conformal doubles became the "*carte du jour*" projections of Europe during the early 20th century, and the cylinder, the cone and the plane were all used as developable surfaces. The "oblique" for this Swiss system is really a misnomer; it's merely transverse at an oblique latitude. The Rosenmund projection is truly unique in the world for a national Grid. The combination of the Bern Observatory (horizontal) Datum of 1898 with the Pierre du Niton (vertical) Datum of 1902 or LN02, and the Rosenmund projection and Grid of 1903 have collectively been known since as the "CH1903 System" (Convention Helvetica 1903 System), of Switzerland.

In 1988, a new network of 104 GPS station observations began, and the resultant adjustment has become the new national (terrestrial) reference system of Switzerland and is called the CHTRS95. The local reference frame realized for the old CH1903 Datum is called LV95. The "CH1903+" was held fixed at a new fundamental point, Zimmerwald $Z_o$ where $\varphi_o$ = 46° 52' 42.27031" N, $\lambda_o$ = 7° 27' 58.41774" East, and $X_o$ = 191,775.0616 m, $Y_o$ = 602030.7698 m., all still referenced to the Bessel 1841. The new point was chosen because the original location no longer exists, and the original coordinates of triangulation point Gurten was kept to maintain orientation. The deflection of the vertical is now defined at Zimmerwald $Z_o$: $\zeta_o$ = +2.64", $\eta_o$ = +2.73", and $H_o$ = 897.8408 m. Transforming CH1903+ Datum to CHTRS95 Datum (WGS84 ellipsoid) then is accomplished by $\Delta X$ = +674.374 m, $\Delta Y$ = +015.056 m, $\Delta Z$ = +405.346 m (*op. cit., Brandenberger 2001*).

The European Datum of 1950 was computed for Switzerland by the U.S. Army Map Service in the 1950s, and to transform from EU50 to WGS84, $\Delta X$ = –87 m, $\Delta Y$ = –96 m, $\Delta Z$ = –120 m. To transform from EU79 to WGS84, $\Delta X$ = –86 m, $\Delta Y$ = –98 m, $\Delta Z$ = –119 m. These parameters are according to *NIMA's TR 8350.2, 3 January 2000*.

According to the Swiss Federal Office of Topography (**SWISSTOPO**), the seven-parameter Datum shift from CH1903+ to WGS84 is: $\Delta X$ = +660.077 m ±4.055 m, $\Delta Y$ = +013.551 m ±4.816 m, $\Delta Z$ = +369.344 m ±3.914 m, $\alpha$ = 2.484 cc ±0.417 cc, $\beta$ = 1.783 cc ±0.455 cc, $\gamma$ = 2.939 cc ±0.411 cc, and M = 1.000000566 ±0.00000566 (*op. cit., Brandenberger 2001*).

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