& GRIDS & DATUMS

THE SWISS CONFEDERATION

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The Grids & Datums column has completed an exploration of every country on the Earth. For those who did not get to enjoy this world tour the first time, *PE&RS* is reprinting prior articles from the column. This month's article on the Swiss Confederation was originally printed in 2001 but contains updates to their coordinate system since then.

The area now known as the Swiss Confederation was occupied by Helvetians who were conquered by the Romans; the southwest was invaded by Burgundians, and the northeast was invaded by Alamanni. In 1291 the Forest Cantons, or provinces of Uri, Schwyz, and Unterwalden, formed an anti-Hapsburg league that became the nucleus of the Confederation. The perpetual neutrality of Switzerland was guaranteed by international agreement in 1815 at the Congress of Vienna and again in 1919 by the Treaty of Versailles. Its present constitution was adopted in 1874. The highest peak of this Federal Republic is Monte Rosa at 4,638 m (15,217 ft). The Swiss Confederation shares borders with France, Germany, Italy, Austria, and the Principality of Liechtenstein.

G. H. Dufour, later to become a general, founded the Eidgenößisches Topographisches Bureau (Topographical Bureau) in Geneva in 1838. Dufour decided to use the "carte du jour" projection of Europe for the time which was the ubiquitous Ellipsoidal Bonne originally used for topographic mapping by Cassini himself during the Napoleonic Campaigns. The grid used for this Ellipsoidal Bonne has a Latitude of Origin (φ_o) = 46° 57′ 06.02″ N, a Central Meridian (λ_o) = 7° 26′ 24.75″ East of Greenwich (5° 06′ 10.80″ East of Paris), a False Easting of 600 km and a False Northing of 200 km. The Berne Observatory Datum was circa 1840, and the ellipsoid used was the Schmidt 1831 where a = 6,376,804 m, and $^1/_f$ = 302.02. Although my notes show a false origin for this old grid, I suspect that the original use was with the traditional quadrant system. The false origin probably crept into use as the base was updated after the Rosenmund System was introduced in the 20th century. From 1845 to 1864, the publication of the first accurate map, known as the "Dufour Map," covering the whole of Switzerland was performed at the scale of 1:100,000;

the slopes were shown by hatchures. By this time, the classical triangulation of Switzerland comprised 40 triangles that had been observed with Kern instruments, and the average error of a figure was 0.86 arc seconds. The Swiss triangulation calculations were based on the Bessel 1841 ellipsoid after 1863 where a = 6,377,397.155 m, and $^1/_f$ = 299.1528. The office was transferred to Berne in 1868, and the publication of the original surveys at 1:25,000 (Swiss Central Plains) and at 1:50,000 (Alps) with contours was performed from 1870-1916. The Old Berne Observatory Datum of 1898 published an Astronomical Latitude (Φ_o) = 46° 57′ 08.66″ N, based on observations executed by E. Plant amour in 1875 and an Astronomical Longitude (Λ_o) = 7° 26′ 22.5″ East of Greenwich. The defining azimuth to station Rötifluh was (α_o) = 11° 12′ 05.24″. The ellipsoid height and deflection of the vertical are not defined and therefor are forced to zero at the origin.

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In 1900, the national mapping agency was renamed the Eidgenößische Landestopographie. The vertical Datum was defined as Repère Pierre du Niton 1902, a large rock in the harbor of Geneva, where H_o = 373.600 m ("Gebrauchshöhe") with a connection to the tide gauge in Marseilles, France. M. Rosen mund, an engineer with the bureau, developed a new projection. The new system is an oblique conformal cylindrical double projection, similar in concept to what General Jean Laborde developed for Madagascar. For the grid of the Swiss National Maps, the value φ_o = 46° 57′ 07.90″ N was chosen based on more recent measurements (1937), and the Central Meridian (λ_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 previously listed 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. Laborde actually used the first oblique cylinder with a tilt at the origin, Rousilhe used the first oblique plane for the stereographic for most of his hydrographic surveys, and Krovak used the first oblique (tilted) cone for the Czech Republic. Rousilhe was the only system developed that became a widely used conformal double projection. 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.

The use of aerial photographs for map making commenced in 1930, although terrestrial photogrammetry was already in common use. By 1938, the first 1:50,000 series of the entire country was completed, and the office moved to a new building in Wabern, near Berne in 1941. The Swiss National Map series was completed at the 1:25,000 scale in 1979, and the first use of satellite receivers for national surveys was in 1979. In 1980 the office was renamed the Bundesamt für Landes topographie, and the first Swiss National map sheet was digitally updated in 1989.

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 φ_o = 46° 52′ 42.27031″ N, λ_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 were kept to maintain orientation. The deflection of the vertical is now defined at Zimmerwald Zo: ζ_o = +2.64″, η_o = +2.73″, and H_o = 897.8408 m. Transforming the CH1903+ Datum the to CHTRS95 Datum (WGS84 ellipsoid) then is accomplished by ΔX = +674.253 m, ΔY = +015.053 m, ΔZ = +405.324 m, according to the Swiss Federal Office of Topography.

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, ΔX = –87 m, ΔY = –96 m, ΔZ = –120 m. To transform from EU79 to WGS84, ΔX = –6 m, ΔY = –98 m, ΔZ = –119 m. These parameters are according to NIMA's TR 8350.2, 3 January 2000.

According to the Swiss Federal Office of Topography, the seven-parameter Datum shift from CH1903+ to WGS84 is: ΔX = +660.077 m ±4.055 m, ΔY = +013.551 m ±4.816 m, ΔZ = +369.344 m ±3.914 m, α = 2.484 cc ±0.417 cc, ß = 1.783 cc ±0.455 cc, γ = 2.939 cc ±0.411 cc, and M = 1.000000566 ±0.000000052. "Different applications of these transformation parameters, particularly in northern Switzerland, have shown that WGS84 coordinates can be computed for all of Switzerland from the national coordinates with an accuracy better than 1 meter (1 sigma)."

Update

Significant geodetic activities have been performed in Switzerland since 2001, and all is reported in National Reports to the International Union of Geodesy and Geophysics (IUGG). The accuracy of the known geoid in Switzerland is considered known to better than a few centimeters, largely due to an enormous amount of observations for the deflection of the vertical (DOV). The European Reference Frame (EUREF) is supported and the country is in full cooperation with all of its neighbors.

1 http://www.bernese.unibe.ch/publist/publist_2015.php.
2 https://iag.dgfi.tum.de/fileadmin/IAG-docs/NationalReports2007/Switzerland.pdf.
3 https://www.swisstopo.admin.ch/en/knowledge-facts/surveying-geodesy/reference-frames/transformations-position.html.
4 File:///Users/cjmce/Downloads/ch1903wgs84_e.pdf.