Republic of Iceland

by Clifford J. Mugnier, C.P., C.M.S.

Iceland's first inhabitants were Irish monks who regarded the island as a hermitage until the early 9th century. "Lyoveldio Island" was permanently settled mainly by Norwegians and by some British Isles Vikings in 874 *AD*. The National Assembly or "Althing," was the world's first parliamentary system in 930. Christianity was adopted (under threat of sword!) in 999, and Iceland united with Norway in 1262. Leif Eiriksson was born in Iceland, and he sailed from Greenland to become the first European to reach North America (Vinland the Good) in 1000. In 1380, Iceland united with Denmark, and by Act of Union in 1918, became an independent kingdom in personal union with Denmark. Iceland became a constitutional republic and independent from Denmark on 17 June 1944.

The terrain is mostly plateau interspersed with mountain peaks and ice fields. The coast is deeply indented by bays and fiords. With a coastline of 4,988 km, the highest point is Hvannadalshnúkur (2,119 m). The land area of Iceland is slightly smaller than Kentucky. The maritime claim is 200 nautical miles or to the edge of the continental margin, and the territorial sea claim is 12 nautical miles. Iceland's maritime claims use the "straight baseline system," which are ellipsoidal loxodromes (rhumb lines) that connect 31 points on the coastline perimeter.

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According to the National Land Survey of Iceland or Landmælingar Íslands (LMÍ), "It is believed that Guðbrandur Þorlaksson, the bishop at Hólar, was the first Icelander to be involved in mapmaking. Guðbrandur lived from 1541 to 1627 and measured the global position of Hólar with amazing precision. A map named after him was published in 1590. Björn Gunnlaugsson, a teacher at Bessastaðaskóli School, made a map of Iceland in 1844. The map was named after him and used for the next 100 years!"

The Reykjavík Datum of 1900 was established by the Danish Army General Staff and published in the *Geodætisk Instituts Publikationer VII, Island Kortlægning* where: Φ_o = 64° 08' 31.88" N and Λ_o = 34° 30' 31.5" West of Københavns (Copenhagen) or Λ_o = 21° 55' 51.15" West of Greenwich. The ellipsoid of reference was the Danish (Andræ) 1876 where a = 6,377,019.25666 m and $1/f$ = 300. The classical triangulation was initially used for planetable mapping at the scale of 1:50,000, but the publication scale was changed to 1:100,000 seven years later. Thirty years thereafter, the first oblique aerial photography was flown in Iceland. The original grid system used for the Reykjavík Datum of 1900 was the Islandic Conformal Conic where: the latitude of origin, φ_o = 65° 00' N, the central meridian, λ_o = 19° 01' 19.65" West of Greenwich, and the scale factor at origin, m_o = 1.0 (tangent conic). There was no false origin used with the grid associated with the Reykjavík Datum of 1900. However, since the conformal conic projection used in Denmark at the time was termed the "Buchwaldt projection," that term might have been also used in Iceland. Colonel Frants Andræs Buchwaldt (1874-1923) was the director of the Geodetic Service of Denmark. (I have noticed that one reference published by LMÍ includes a Danish paper authored by another Buchwaldt in 1976.) The datum shift parameters (in standard military "3-parameter Molodensky" form) from the Reykjavík Datum of 1900 to the WGS 84 Datum are: Δa = –1118 m, Δf = –0.0000195, ΔX = –636 m, ΔY = +21 m, ΔZ = –934 m. An official notice states, "All maps on a scale of 1:100,000 published by Landmælingar Íslands are currently provided in Reykjavík 1900 datum. In the available map scales Reykjavík 1900 differs significantly from WGS84. … In case of the 1:50,000 map scale the available maps are provided in two different series first published before and after 1955. For those published after 1955 the horizontal datum is Hjörsey55 as indicated in the map legend. For those published before this threshold the phrase *Horizontal Datum is based on the Astronomic Station of Reykjavík; 21°55'51.15"West of Greenwich, 64°08'31.88"* indicates the Reykjavík 1900 datum. For a variety of technical reasons it is impossible to obtain transformation parameters with high accuracy and nationwide validity. However, for navigational purposes (*e.g.* hiking) a set of transformation parameters has been derived from graphical comparisons. Although they proofed *(sic)* to be useful for orientation with the LMÍ maps they do NOT provide geodetic accuracy! In average, from WGS84 towards Reykjavík 1900, a point requires a horizontal shift of approx. 200m westwards resp. 25m southwards (±25m)."

The same document that originally listed the Reykjavík Datum of 1900 included another, the Akureyri Datum of 1900. Thanks to John W. Hager: "For Akureyri I have latitude (Φ_o) = 65° 40' 15.2" N ±0.2" or 15.8" N ±0.1" and longitude (Λ_o) = 18° 05' 12.6" W ±09.0". … I was in Akureyri earlier this year and tried, using my GPS, to locate the position but was not able to do so. Time was very limited. Suspect that the point is in the area of the botanical gardens and the hospital." Although this apparent "astro" station represents an obsolete local datum, the U.S. Army Map Service (AMS) noticed that several 1:100,000 scale maps in the region of the town of Akureyri "did not agree with the control values by several seconds *(of arc – Ed.)*." This notation was dated 20 December 1946 by William W. Baird, AMS.

When Denmark was occupied during WWII, Iceland petitioned for independence. That was granted in 1944 as mentioned above, and the United Kingdom and the United States subsequently moved in because of wartime concern for the island's vulnerability. An interim datum was computed apparently for cartometric purposes and is locally termed the Reykjavík 1945 datum referenced to the Hayford 1909 (International 1924) ellipsoid. In 1955, a new classical triangulation and

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geodetic survey was initiated by Denmark and the United States. The following year, the LMÍ was founded. The new survey established the Hjörsey Datum of 1955 where: Φ_o = 64° 31' 29.26" N and Λ_o = 22° 22' 05.84" West of Greenwich and the ellipsoid of reference is the Hayford 1909 (International 1924) where: a = 6,378,388 m and $1/f$ = 297. The grid system devised by AMS for the new datum was the Icelandic Gauss-Krüger Transverse Mercator with four belts (1-4) where the central meridians, λ_o = 15°W, 18°W, 21°W, and 24°W, the scale factor at origin, m_o = 1.0, and the False Easting of each belt = 500 km. However, it appears that LMÍ ignored the Transverse Mercator devised by AMS and instead utilized another Lambert Conformal Conic zone where: the latitude of origin, φ_o = 65° 00' N, the central meridian, λ_o = 18° West of Greenwich, and the scale factor at origin, m_o = 1.0 (*another* tangent conic), and the False Easting = False Northing = 500 km. The datum shift parameters published by NGA in *TR8350.2* from the Hjörsey Datum of 1955 to the WGS 84 Datum are: Δa = –251 m, Δf = –0.14192702, ΔX = –73 m ±3 m, ΔY = +46 m ±3 m, ΔZ = –86 m ±6 m, and this solution is based on 6 points. A 7-parameter Bursa-Wolfe transformation published by LMÍ from the Reykjavík Datum of 1900 to the Hjörsey Datum of 1955 *(rotations changed to the U.S. Standard – Ed.)* is where: ΔX = +629.020 m, ΔY = –214.701 m, ΔZ = +1028.364 m, R_x = –4.154", R_y = +0.269", R_z = +2.279", Δs = –3.729.

A geodetic surveying campaign was carried out by "Icelandic and German agencies for the purpose of establishing a new horizontal geodetic datum in Iceland. The work culminated in a GPS-campaign named ISNET93 during 3-13 August 1993. The associated new geodetic datum is named ISN93. It will replace the Hjörsey-1955 datum established by terrestrial observations in 1955-56." (*GPS-mælingar í grunnstöðvaneti 1993)*. A 7-parameter Bursa-Wolfe transformation published by LMÍ from the Reykjavík Datum of 1900 to the ISN93 *(rotations changed to the U.S. Standard – Ed.)* is where: ΔX = +556.020 m, ΔY = –168.701 m, ΔZ = +942.364 m, R_x = –4.154", R_y = +0.269", R_z = +2.279", Δs = –3.729, and the ellipsoid of reference is the GRS 1980 where a = 6,378,137 m, and $1/f$ = 298.257222101. LMÍ does offer a free interactive coordinate transformation service (*cocodat*[i]) through the Internet. The new grid system adopted is the ***secant*** Lambert Conformal Conic projection with standard parallels 65° 45' N and 64° 15' N, and central meridian 19° W. False Eastings = False Northings = 500 km at 65° N and 19° W. The GPS network consists of 119 stations, of which 63 are pillars and the remainder are benchmarks in bedrock. Thanks to Gunnar Þorbergsson for his historical accounts of the Icelandic datum relations recorded in exquisite detail.

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