

Grids & Datums

HASHEMITE KINGDOM OF JORDAN

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

According to Webster's New Geographical Dictionary, "Created (as Transjordan) 1921 out of former Turkish territory and proclaimed an independent state 1923 under Emir Abdullah ibn al-Husayn, but a mandate under British protection; mandate revoked 1946 and by treaty of March 1946 became an independent kingdom." The kingdom is slightly smaller than Indiana, and borders Iraq (181 km), Israel (335 km) (*PE&RS*, August 2000), Saudi Arabia (744 km), and Syria (375 km) (*PE&RS*, September 2001). Jordan is mostly desert plateau in the east, and highland in the west. The Great Rift Valley separates the East and West banks of the Jordan River, the lowest point is the Dead Sea (-408 m), and the highest point is Jabal Ram (1,734 m).

The Office of the Geographer, U.S. Department of State provides background on the Jordan - Saudi Arabia Boundary: "The new boundary passes through a desert or near desert area of limited economic potential; the frontier is virtually rainless (under 2 cm everywhere) and almost devoid of population. Scattered wells and access to the Gulf of Aqaba (for Jordan) are the primary points of strategic value.

"The frontier region is a tilted plateau with the highest elevation in the west and the lower in the east. The interior district is composed of sand areas interspersed with eroded lava flows, which are dissected by dry streambeds. A few peaks attain elevation of 1000 m, approximately 300 m above the average elevation of the plateau. The general alignment of the drainage pattern is toward the south and east reflecting the slope of the plateau. Soil, except in the wadi bottoms, is very thin or non-existent.

"Close to the shores of the Gulf of Aqaba, the border traverses the escarpment marking the edge of the Dead Sea - Jordan - Aqaba fault valley. The escarpment, in places, looms 1,400 m above the level of the adjacent sea. However, many dry watercourses dissect the escarpment into a series of broken blocks. A narrow coastal plain fringes the shores of the Gulf with relatively easy access to the interior furnished by the numerous wadi beds.

"After the end of World War I, Great Britain received a League of Nations mandate for Palestine encompassing Jordan. The British soon divided the mandate for administrative purposes along the Jordan River - Wadi Araba line. However, the precise southern limits of Palestine and Trans-Jordan were indefinite. At the time, Britain claimed access to the Gulf of Aqaba, while the Arabians considered Ma'an, about 80 km to the north, to be within their domain based on its inclusion in the Ottoman Vilayet of the Hejaz. The adjacent parts of Arabia were occupied by the independent sultanates of the Nejd and Hedjaz, which later became the core of the Kingdom of Saudi Arabia (1932). In the middle of the 1920s, Britain began a series of negotia-

tions with the Arabian sultanates to settle the southern limits of both the Trans-Jordan and the Syrian mandates. The eastern and central sectors were agreed upon in 1925 with the disputed Kaf region being assigned to the Nejd. The western sector of Jordan with the Hejaz, however, could not be agreed upon. Britain ultimately delimited the boundary unilaterally to include within Trans-Jordan a narrow outlet on the Gulf of Aqaba. This action was rejected by the Hejaz and later by the combined kingdom of Saudi Arabia. King Ibn Saud, however, did agree to maintain the status quo pending a solution to the dispute.

"In 1946, Trans-Jordan became independent as the Hashemite Kingdom of the Jordan, with the boundary problem still unsolved. Efforts were made in 1961-63 to settle the question, again to no avail. Finally in 1965, a mutually acceptable line was delimited. Jordan gained an enlarged coastline (19 kilometers) on the Gulf of Aqaba and 6,000 km² of territory in the interior. In turn, 7,000 km² of Jordanian-administered territory were ceded to Saudi Arabia. The new boundary came in to effect on November 7, 1965. The TAP line (Trans-Arabian Pipeline) crosses the boundary at approximately 31° 13' East. The pipeline is currently the most important economic feature crossing the boundary."

Early mapping (pre WWI) of the area comprising the Kingdom of Jordan were small-scale compilations by the Ottoman Turks and were cast on the ellipsoidal Bonne projection. Large-scale mapping was confined to local planetable compilations for cadastral tax applications. This constituted the first Tabu (land registry office) in 1857 in the Greater Syrian town of Bilad Ash Sham. Modern mapping was accomplished by the British Army Middle East Land Forces (MELF) for the Trans-Jordan-Nejd Boundary 1:100,000 scale series. In 1937, the Trans-Jordanian Department of Lands and Surveys took over from the Survey of Palestine the responsibility for mapping the area east of the Jordan River, and carried on the work under British direction. Work in the northern part of the area was done in cooperation with the Free French Forces in Syria and Lebanon. Before WWI, southwestern Palestine was mapped by the British War Office cooperatively with the Survey of Egypt. Although the British Mandate of Transjordan ended in 1946, the Department of Lands and Surveys, Transjordan and later Jordan continued to work, with varying degrees of closeness, with mapping services of the British Army. During and immediately following WWII, topographic mapping in Transjordan was conducted by survey units attached to MELF. Among the MELF publications covering parts of Transjordan were three series at scales of 1:25,000, three at 1:50,000, and one at 1:500,000. From 1914-1915 the British Directorate of Military Survey published the Africa 1:125,000 Sinai Peninsula series and in 1943 the 1:50,000 Transjordan Lava Belt series.

continued on page 1318

Thanks to John W. Hager, the military mapping of Jordan was referenced to the Palestine Datum of 1928 which has its origin at station Number 2 where: $\Phi_o = 31^\circ 18' 06.27''$ North, $\Lambda_o = 34^\circ 31' 42.02''$ East of Greenwich, the ellipsoid of reference is the Clarke 1880 where $a = 6,378,300.78$ meters, $1/f = 293.466308$, and elevation = 98.9 m. The Gauss-Krüger (military) Grid (origin adopted is the principal point 82'M (Jerusalem) having the geographic coordinates $\phi_o = 31^\circ 44' 02.749''$ N, $\lambda_o = 35^\circ 12' 39.29''$ East of Greenwich + 04.200" E = $35^\circ 12' 43.490''$. The addition of 04.200" to the longitude is in accordance with the decision in 1928 to adopt the French value for the longitude at the points of junction 73'M and 98'M in the north, and to correct all Palestine (and Transjordan) longitudes accordingly. Palestine longitudes were originally based on those of Egypt at the Transit of Venus station, and a correction of 3.45" was indicated to the Egyptian longitudes. Imara Base (1'M or 5'DM) is the original false origin of the Grid coordinates (i.e., FN = 126,876.909 m, FE = 170,251.555 m), and 1,000,000 meters is added south of the false origin to avoid negative numbers.

After WWII, the U.S. Army Map Service (AMS) decided to eliminate all of the individual datums and grid systems of Europe, the Mid-East, and North Africa and to combine all into a single datum called the European Datum of 1950. The origin was at the Helmeturm (Helmert's Tower) in Potsdam, Germany where: $\Phi_o = 52^\circ 22' 51.446''$ North, $\Lambda_o = 13^\circ 03' 58.928''$ East of Greenwich, and was referenced to the International 1924 ellipsoid where $a = 6,378,388$ m, and $1/f = 297$. AMS did convert all of the Palestine and Jordan to the European Datum of 1950. The method used was a conformal transformation on the complex plane using UTM coordinates. Thanks to a memo by Isaac C. Lail, (AMS, 1957): "The Transjordan Triangulation Extension was initiated in 1937 by the Department of Lands and Surveys, Amman and is based on the major triangulation of Palestine. The connection for the northern arm is at the stations 52M, 53M, and 54M and to the south, the stations are 44M, 89M, and 92M. Using the sides between these points as a base the triangulation was extended eastwards into Transjordan. The stations were occupied and their lengths of sides were accepted from the major triangulation of Palestine as the starting base. The mean triangle closure from the beginning of the extension to points 169M, 172M, and 176M was 7.9". The triangles to the east of these points had larger closures of up to 13". Therefore, this extension was considered to be of 3rd order accuracy. The Palestine-Transjordan Chain starts on the Palestine major stations 11M, 12M, and 13M and connects with the Egyptian stations E10, F10, G10, and H10 and then goes along the border of Egypt to the Gulf of Aqaba. From the gulf it goes north through Transjordan

to the area of Jericho and closes on the Stations 92M and 44M of the Palestine major net. The chain had 121 triangles, which had a mean closure of 2.4" with a maximum of 9.4" and only 11 of the 121 triangles had a closure of over 5". Thus, the chain was considered to have 2nd order accuracy. The bases, differences between measured and calculated lengths have errors as follows: 201M-202M = 1/35,000 and 157M-182M = 1/320,000. Three astronomical azimuths were taken as stations 196M, 205M, and 137M. The results were consistent but varied with computed values from the coordinates.

"The British Army contracted a civilian surveyor, Kolomojtzeff in 1942 to observe a major triangulation connecting the Syrian Cadastral Primary Triangulation to the Existing work in Transjordan but it was not fully completed and it is said that the computations were not carried out in a rigorous manner. The net started from two Syrian primary stations, Tell El Aarar and Chababiye. Another station, Tell Koulib, was used but not occupied. Three of the Transjordan Extension stations and four of the Palestine Transjordan Chain stations were reoccupied. Then to the east and south to 31° N, Kolomojtzeff observed 21 new stations."

Based on a solution I derived about 20 years ago (see *PE&RS*, August 2000), the local datum shift from Palestine 1928 Datum to European Datum 1950 is: $\Delta X = -76$ meters, $\Delta Y = +64$ meters, $\Delta Z = +442$ meters.

The Royal Jordan Geographic Center (RJGC) was established in Amman in 1975. The process of computerization of all Jordanian land records is complete and the new grid system, the Jordan Transverse Mercator (JTM), is based on 6° belts with a Central Meridian of 37° East and a Scale Factor at Origin (m_o) = 0.9998. "The National Geodetic Network is a high accuracy Doppler-based geodetic network," and the ellipsoid of reference is reported to (strangely) remain as the International 1924! No transformation parameters are presently offered by the government. However, thanks to Prof. Steven H. Savage of Arizona State University, the JTM has a False Easting of 500 km, a False Northing of -3,000 km, and the three-parameter transformation to WGS84 is: $\Delta X = -86$ meters, $\Delta Y = -98$ meters, and $\Delta Z = -119$ meters.



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