Grids & Datums

Tunisian Republic

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

Tunisia was a Roman province of Africa from the 2nd century B.C. to the 9th century A.D. when the Vandals overran it. Reconquered by the Byzantine Empire in the 6th century, it was then taken by Muslims in the 7th century. Both Libya and Tunisia came under Turkish suzerainty in the latter half of the 16th century. The former Barbary state engaged in piracy in the 19th century was later the subject of a dispute between France and Italy, and was eventually invaded by France and became a French protectorate in 1881. "An agreement in 1886 between France and Turkey delimited a boundary between Tunisia and the Turkish vilayet of Tripoli in western Libya from the Mediterranean inland for a limited distance. A second agreement in 1892 delimited the boundary with greater accuracy than previously and inland as far as Ghudämis. On May 19, 1910, a Franco-Turkish convention delimited the present day Libya-Tunisia boundary which was demarcated with pillars by a joint commission in 1910-1911." (*International Boundary Study No. 121 – April 7, 1972 Libya-Tunisia Boundary, Department of State Bureau of Intelligence and Research, Issued by the Geographer*).

The Tunisian government was reorganized in 1922, occupied by the Germans in 1942, captured by the U.S. and British forces in 1943, and was recognized by France as independent in 1956 (*Merriam-Webster's Geographical Dictionary, 3rd edition*). The republic is located in Northern Africa, and is bordered by the Mediterranean Sea (1,148 km), Algeria (965 km) (*PE&RS*, October 2001), and Libya (459 km) (*PE&RS*, June 2006). Tunisia is slightly larger than Georgia, and has mountains in the north; it has a hot, dry central plain, and the semiarid south merges into the Sahara desert. The lowest point is Shatt al Gharsah (–17 m), and the highest point is Jebel ech Chambi (1,544 m) (*CIA World Factbook, 2006*).

"The origins of the Topography and Cartography Office *(Office de la Topographie et de la Cartographie*), date as far back as the 15th of July 1886, when the Topographic Service was born, in application of the Real Estate Law dated 1st July 1995. This service became the Topographic Division on the 1st January 1968, then the Topographic and Cartographic Department on the 5th January 1970. The Topography and Cartography Office was established on the 25th of December 1974, by law no. 74-100, as a public enterprise with an industrial and commercial character, under the supervision of the Ministry of the Equipment, Housing and Land Management" (*Republic of Tunisia Topography and Cartography Office*).

Prior to independence in 1956, official topographic mapping was carried out by the *Service Géographique de l'Armée* (Geographic Service of the Army) and later by the *Institut Géographique National – IGN* (National Geographic Institute), both of France. The maps ranged in scale from 1:10,000 to 1:1,000,000. Some of the mapping was delegated by *IGN* to the *Service Topographique* of Tunisia, and it performed local surveys for civil use, reconnaissance work, and it also produced cadastral maps. In 1915, the French Navy Hydrographic Surveyor, Commandant Léon Pélissier, established a local grid system for the Triangulation of La Porte du Lac de Bizerte where the origin of the local grid was at Dhebel Iskeul and where: (φ_o) = 37° 07' 22.1" N, and the Central Meridian (λ_o) = 7° 19' 00.3" East of Paris (*Annals Hydrographique, Paris, le février 1926*). Note that X and Y were set to null, as usual for that time. Chances are, the local grid was computed on the Hatt Azimuthal Equidistant projection, but was computed on the Germain ellipsoid (*Annals Hydrographique, 3e série Tome Quatriéme Année 1921*).

The general triangulation of Tunisia was started in 1883 and was completed in 1908. There are two main triangulation chains in Tunisia: the sector of the North African parallel running through Tunisia – the west-east chain prolonging the Algiers parallel – to the end of Cap Bon peninsula; and the chain of the meridian of Gabés, stretching from Tunis to Métameur. The coordinates were computed on the Colonne Voirol Datum of 1875 (of Algeria), commonly termed Voirol 75. The fundamental point is at the geodetic pillar of the Colonne Voirol Observatory (near Algiers), and the astronomical coordinates are: Φ_o = 36° 45' 07.9" N (40^{G}8357.8"), Λ_o = 3° 02' 49.45" East of Greenwich (0^{G}7887.3" East of Paris). The reference azimuth *from south* to Melab el Kora is: a_o = 322° 16' 52.7", and the ellipsoid of reference is the Clarke 1880 (*IGN*) where a = 6,378,249.2 m, and $1/f$ = 293.4660208. An interesting ancient comment about observations at Colonne Voirol was that the baseline originally measured with the bi-metallic apparatus of Porro in 1854 was re-observed with superior accuracy subsequently obtained with the mono-metallic apparatus of INVAR steel in 1912 (*Section de Géodésie du Service Géographique de l'Armée, 1924, Bulletin géodésique Année 1925, No. 8*). There was no net adjustment made. Computation of coordinates was carried out progressively with the fieldwork. The results of these computations are contained in 34 folios entitled "*Description Geometrique de la Tunisia*." Between 1912 and 1926 the first order net was adjusted with three bases included in the adjustment. Coordinates were computed on the Carthage Datum of 1925. The first order complementary and some second order control was adjusted on the Carthage Datum in 1934. The elements of the Carthage Datum of 1925 are at the origin point being the astronomic station Carthage (observed in 1878) where: Φ_o = 36° 51' 06.5" N, Λ_o = 10° 19' 20.645" East of Greenwich (07° 59' 06.7" East of Paris). The reference azimuth from south (from Carthage) to Marsa is: a_o = 180° 01' 00.9", and the ellipsoid of reference is the Clarke 1880 (*IGN*), (*James W. Walker, U.S. Army Map Service, 22 November 1957, and Mémorial du Dépôt Général de la Guerre, t. XI, fascicule 3, p. 382*). The original French mapping was cast on the ellipsoidal Bonne projection – the ubiquitous projection du jour for the Europeans of the time. The North African (ellipsoidal) Bonne Grid Latitude of Origin: (φ_o) = 35° 06' N (39G00 N), the Central Meridian (λ_o) = 2° 20' 13.95" East of Greenwich,

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and some time before WWII, the False Easting and False Northing were changed from zero to 100 km for each. Interestingly, this old Bonne Grid still influences current mapping in that Grid limits of the Lambert Conic Grids are still defined by Bonne Grid values. The sheet boundaries of the new Lambert Grids are commonly computed by a reversion of the late Prof. Karl Rinner's Bonne power series formulae published in *Zeitschrift für Vermessungswesen* during the 1930s. That reversion allows cartographers to compute the intersection of a constant Bonne Grid value with a chosen arc of the parallel or of the meridian. Those intersections then were used to define the limits with the graticule of the Lambert Conic Grids computed in 1974 by John W. Hager, now retired from AMS/TOPOCOM/DMA/NIMA/NGA.

The projection used for the topographic mapping on the Carthage Datum of 1925 was the Lambert Conformal Conic in two different secant zones: North and South Tunisia separated by the parallel of 38^G50 and having the following parameters for North Tunisia the Latitude of Origin (φ_o) = 36° North (40^G), the Central Meridian (λ_o) = 11^G East of Greenwich, and the Scale Factor at Origin (m_o) = 0.999625544, and for South Tunisia the Latitude of Origin (φ_o) = 33°18' North (37^G), the Central Meridian (λ_o) = 11^G East of Greenwich also, and the Scale Factor at Origin (m_o) = 0.999625769. (Note that only the Central Meridians have different parameters from the Algerian Lambert zones.) The False Origin is 500 kilometers for Eastings and 300 kilometers for Northings *for both zones*, the same convention as used in the Kingdom of Morocco (*PE&RS*, June 1999) and in Algeria. In 1970, the French *IGM* developed on contract to the U.S. Army Topographic Command (TOPOCOM – my old duty station), some nomograms for converting from the Carthage 1925 Datum of Tunisian to the European Datum of 1950. "The nomograms involved not only a mathematical conversion due to the change in ellipsoid and geodetic system, but also an experimental correction of the imperfect early adjustments of local geodetic systems. The nomograms are based on hasty maps. The values of the corrections are to be taken as functions of the geographic coordinates, disregarding the alignment of the coast line and the triangulation points whose location is very much guesswork" (*COL du JEU, Chief Military Geographic Section, Ministry of State for National Defense of France, 16 June 1970*). A subsequent caveat discussed the imperative for extraordinary care in dealing with coordinate transformations in this region of North Africa and stressed that the maximum accuracy likely obtained under the best of circumstances is "several meters and this appears to be satisfactory for scales of 1:50,000 or less."

The first general precision leveling net of Tunisia was begun between 1887 and 1889. After fairly long interruptions, fieldwork resumed in 1903 and continued intermittently until 1909. It was completed from 1913 to 1914. In the process 2,118 km of roads and railways were leveled by the Army Geographical Service. Nevertheless, no absolute elevations were calculated at this time. In 1920 the calculations were made following the methods of the French general leveling survey, and the whole network was adjusted by the method of least squares, despite certain excessive closure errors. The altitude datum for this network was the Porte de France console at Tunis. Its altitude of 6.9 meters was calculated from the daily readings of the tide gauge installed in the port of La Goulette in 1889 (*Ed. – That satisfies the geodetic/hydrographic convention of a minimum of one Metonic cycle of 18.6 years*).

The numerous errors which had crept into the observations, which came to light when the altitudes of certain benchmarks near the Algerian-Tunisian frontier (calculated under both the Algerian and the Tunisian system) were compared, together with the appreciable closure errors, disturbed the officials of the Topographical Department and led them to check calculations already made. Eventually certain sections were resurveyed and four fascicles of altitudes were published in December 1926. Faced with this confused situation, in 1959 the Topographical Department decided to renew the precision leveling net completely.

"The new Tunisian precision leveling network surveyed by the Topographical Department consists of eleven first-order traverses and eleven peripheral zones, covering a distance of some 3,039,900 km and comprising 1,400 reference points and 2,324 benchmarks. Three hundred and thirty benchmarks belonging to the old network were incorporated into the new one. The fieldwork was begun on 15 February 1959 and completed on 28 February 1962."

Photogrammetry was initially employed in Tunisia in 1935 and was furnished by foreign governments. By 1964, the Department acquired a Zeiss C8 Stereoplanigraph equipped with an Ecomat. (*Ed. – A beautiful instrument model that I used and taught with for about 20 years at the University of New Orleans.*) "In addition, a WILD A8 Autograph and WILD B8 stereoplotter was put into service at Tunis by the end of 1965. In 1963 a laboratory equipped both for rectifying (with a Zeiss SEG V rectifier) and for printing aerial photographs (Zeiss KG30 contact printer, Zeiss reducer) was added to the existing cartographic reproduction laboratory (equipped with a Klimsch Super Autohorika)" (*Cartographic Activities in Tunisia – Selim Benghachame, Chief of the Topographical Service*).