Grids & Datums

Maps in the Middle of Nowhere

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

Over the years, inquiring minds have contacted headquarters of the American Society for Photogrammetry and Remote Sensing for information regarding the "Grids and Datums" for countries that had not yet had a column published. In April 2000 "The Basics of Classical Datums" was published in *PE&RS*, and was a minor revision of the original column published in July 1997. This was a general explanation of the techniques utilized in the establishment of all of the major classical horizontal datums of the world, and also covered the majority of the minor classical datums. A starting point was selected for astronomical observations to determine the astronomic latitude (Φ_o) of the origin and the astronomic longitude (Λ_o). With an observed direction to another survey station from an astronomic pole (α_o), a distance was measured to establish scale, and triangulation proceeded by computing the law of sines to establish the geodetic latitude (φ) and geodetic longitude (λ) of additional control points.

Many areas of the world have been geodetically surveyed and topographically mapped using these common classical techniques since *Snellius* in the 1700's. However, not all areas that have been mapped were controlled by these methods. The major European powers have generally followed these techniques in easily-accessible regions, but have modified their methods and techniques for regions that did not offer sufficient potential for economic return. Aerial photography and radio time service offered the technological breakthroughs to map vast areas in the middle of nowhere. Photo-identifiable points were selected of existing features or created through site construction prior to aerial photography, and were surveyed by purely astronomical methods. Sometimes the astronomical observations of these points ("Astro Stations') were performed with the use of elaborate theodolites, other times with geodetic astrolabes, a convenient instrument preferred by naval observers. With times observed through telegraph lines or radio broadcasts, astronomical latitudes (Φ) and longitudes (Λ) were determined at selected sites intended to control aerial photo mosaics. Nowadays, we have the luxury of personal GPS devices for phenomenal positioning accuracy. During the 20th century, "Astro Station" accuracies were commonly only good to a few hundred meters! National governments computed geodetic books of tables referenced to particular ellipsoids they favored such as the Clarke 1880 for British, French and Belgian colonies in Africa and the Middle East; the Clarke 1866 for Portuguese colonies in Africa; the Everest 1830 for the Survey of India throughout southern and eastern Asia; the Bessel 1841 for German Africa, for Japan and its possessions, and for the Netherlands and its possessions, etc. For example, from 1950-1970 U.S. Army Topographic Engineer Officers were issued a set of geodetic tables that *in toto*, weighted about 40 pounds and the set was comprised of ellipsoidal geodetic functions for all five of the standard ellipsoids used for UTM mapping worldwide. (*I still have my set – somewhere. – Ed.*)

More often than not in European colonial territories, scale was not established by precise invar wires in remote areas. With the advent of aerial photography, the astronomical coordinates were plotted onto controlled grids via the selected ellipsoidal books of tables, and bolts of linen cloth were overlain as foundations for paper contact aerial prints to be mosaicked and glued together. *Scale was provided cartometrically in the office and not geodetically in the field.* Planimetric maps were then compiled from these Astro-controlled mosaics with form lines introduced as topographic features. Control of tip, tilt, and perspective was commonly ignored (assumed to be nil) in the haste of producing some sort of cartographic product for mapping coverage. In many areas of the world, that is what still exists for a map. Tri-Metrogon photography (one vertical camera and two oblique cameras), invented by Fairchild for the U.S. Army Air Corps during WWII was utilized by many national air forces after the war as the primary system for imagery capture.

U.S. Army Topographic Engineer Officers in 1950-1970 were issued a set of geodetic tables that *in toto*, weighted about 40 pounds and the set was comprised of ellipsoidal geodetic functions for all five of the standard ellipsoids used for UTM mapping worldwide. *(I still have my set – somewhere. – Ed.)*

Such is the state of mapping in many remote areas of the world, notwithstanding the enormous accomplishments of the former U.S.S.R. The term, *"ersatz datum"* refers to precisely this type of mapping control with "Astro Stations." No true classical geodetic datum exists; only an ellipsoid of reference because of the book of tables used to draft a graticule for the plotting of coordinate control for photo mosaics. The use of orbital imagery in conjunction with *ersatz datum* control will yield frustrating results because of the inconsistency of the original cartographic compilation. Sometimes, orbital imagery is far superior in geometric fidelity than existing paper maps or digital data derived from digitized paper maps. Moral of the story: *check the metadata*.

✧