

& GRIDS DATUMS

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REPUBLIC OF YEMEN

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 Republic of Yemen was originally printed in 2003 but contains updates to their coordinate system since then.

Around 1000 *BC* the region of present Yemen was ruled by three successive civilizations: the Minaean, the Sabaean, and the Himyarite. These three kingdoms all depended for their wealth on the spice trade, consisting mainly of frankincense and myrrh. By the 11th century *BC*, land routes were greatly improved throughout Arabia by using the camel as the beast of burden. Frankincense was carried from its production center at Qana (now Bir'Ali) to Gaza. The chief incense traders were the Minaeans, who established their capital at Karna (now Sadah), before the Sabaean era in 950 *BC*, which lasted for about 14 centuries. The region was invaded by the Romans in the first century *AD*; by the 6th century *AD*, it was conquered first by the Ethiopians (*PE&RS*, March 2003), and then by the Persians. The region converted to Islam in the 7th century. North Yemen became independent of the Ottoman Empire (Turkey) in 1918. The British had set up a protectorate area around the southern port of Aden during the 19th century, but withdrew in 1967 from what had become South Yemen. After two decades of hostilities, the two countries were formally unified as the Republic of Yemen in 1990.

Yemen is bordered by Saudi Arabia on the north (1,458 km), Oman on the east (288 km), the Arabian Sea and Gulf of Aden to the south, and the Red Sea to the west (1906 km). Slightly larger than twice the size of Wyoming, the country is comprised of a narrow coastal plain backed by flat-topped hills and rugged mountains with dissected upland desert plains in the center that slope into the desert interior. The lowest point is the Arabian Sea and the highest point is Jabal an Nabi Shu'ayb at 3,760 m.



Original classical triangulation of Western Aden was done by the British Survey of India in the early 20th century. The first large-scale map series, based on ground surveys, was published in 1917. Later updated, the Aden GSGS 3879 series at 1:126,720 scale was published as a polychrome series in 1930. Carl Rathjens and Herman von Wissmann published the *Karte des Reisegebiets in Jemen* (Map of the Region Traversed in Yemen) in 1934. There was no grid on the map at 1:100,000 scale, and it covered a limited area of Yemen between Şan'ā' and the coast. The three-part poly-chrome map was based on road surveys, supplemented with diaries, sketches, and maps from other travelers. Relief was represented by form lines or hachures.

In 1925, the British Survey of India established the Aden Zone Lambert Conical Orthomorphic grid where the latitude of origin $\phi_0 = 15^\circ$ N, central meridian $\lambda_0 = 45^\circ$ E, scale factor at the latitude of origin $m_0 = 0.999365678$, False Easting =

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1,500 km, and False Northing = 1,000 km. This typical “British Grid” had its limits of zone listed as “North: 150,000 meter Northing grid line of the Mecca-Muscat Zone (Lambert Conical Orthomorphic projection), East: Meridian of 60°E, South: From meridian of 60°E, southwest along loxodrome defined by the points 14° 30′ N, 56° E, and 11° 30′ N, 44° E., West: Loxodrome from 44° E, 11° 30′ N toward 19° N, 39° E, to intersection of 150,000 meter Northing grid line of Mecca-Muscat Zone with the loxodrome.” The ellipsoid of reference is the Clarke 1880 where $a = 6,378,249.145$ m and $1/f = 293.4663077$. Curiously, no datum was listed by the British General Staff, Geographical Section (GSGS). However, reading the Survey of India Triangulation Dossiers reveals that all British chains in the region were based on the original Nahrwan Datum of Iraq where $\Phi_0 = 33^\circ 19' 10.87''$ N, $\Lambda_0 = 44^\circ 43' 25.54''$ E, and the orientation is based on the azimuth from South End Base of Nahrwan (“1M”) to “2M” as $\alpha_0 = 169^\circ 04' 08.2''$ from south. In my opinion, the original classical datum of Yemen (“Aden Datum of 1925”) is actually the British-observed Nahrwan Datum. A test point provided by the U.S. Army Corps of Engineers, Lake Survey Unit in 1943 for Aden Zone is $\phi = 13^\circ 53' 46.728''$ N, $\lambda = 37^\circ 37' 19.732''$ E, $X = 703,075.269$ m, $Y = 891,245.290$ m, $\theta = -1^\circ 54' 34.3032$, and $m_\phi = 0.91412282$.

Numerous map series of Aden and Şan'ā' were produced by the British and U.S. militaries in the period between 1950 and 1961. Scales varied from 1:10,000 to 1:100,000. Other datums reported to exist include Kamaran (Island) Datum of 1926-1927, Ras Karma (Island) Datum, Socotra (Island) Datum of 1957, and Socotra (Island) Datum of 1964-1965. All of these island “astro” datums are presumably referenced to the Clarke 1880 ellipsoid.

A curiosity in large-scale map projections was developed by the U.S. Geological Survey when a mapping project was completed of Şan'ā' in the 1960s. The Şan'ā' Azimuthal Equidistant Grid System was defined by the latitude of origin $\phi_0 = 15^\circ 37' 2''$ N, central meridian $\lambda_0 = 42^\circ 59' 32.25''$ E, scale factor at the latitude of origin $m_0 = 1.0$, False Easting = 40 km, and False Northing = 20 km. The International ellipsoid was chosen for the grid, and the datum was presumably ersatz.

Yemen and Oman established their boundary in an 01 October 1992 agreement consisting of straight-line segments connecting eight turning points defined on the WGS84 Datum. The eighth point is a tripoint with Saudi Arabia. On 18 April 2001, Yemen signed a cooperation agreement based on

the 1999 International Tribunal resolution of the Permanent Court of Arbitration, the Hague, the Netherlands. In 2000, Yemen and Saudi Arabia agreed to a delimitation of their common border.

Large-scale local topographic maps of Yemen are controlled by the government. However, complete topographic coverage of the country is available from commercial map sellers worldwide in the form of Russian military mapping at the scales of 1:200,000 and 1:100,000. Considering the availability of these recent up-to-date Russian maps and the phenomenal accuracy achieved nowadays with shirt-pocket-sized consumer-grade GPS receivers, such secrecy of the Yemeni government is merely restricting the economic development of their own nation.

Yemen Update

In January, 2006, a **TOTAL** (French Oil Company) document was released by the Yemen LNG Co., Ltd. About the “Geodetic Systems on Pipe Line project.” The new “Official Yemen Horizontal Datum is listed as Sana’a – IGN reference marker, calculated on ITRF91 (epoch 92.5) YGN96 (WGS84). The document lists the “Old South Yemen (OSY) Datum referenced to the Krassovsky 1940 ellipsoid where $a = 6,378.245.00$ m and $1/f = 298.3$ with a transformation to YGN96 (WGS84) Datum as: $\Delta X = -76$ m, $\Delta Y = -138$ m, $\Delta Z = +67$ m, “Datum shift provided by the French *Institute Géographique National* in October 1996. An example Transformation Test Point is offered for Geodetic marker BH-01 Datum OSY: $\phi = 13^\circ 59' 06.145''$ N, $\lambda = 48^\circ 10' 41.197''$ E, $h = 23.89$ m., and Datum YNGN96: $\phi = 13^\circ 59' 09.5087''$ N, $\lambda = 48^\circ 10' 40.0179''$ E, $h = -0.730$ m., $H = 18.220$ m. “Geoid model: a local geoid model computed by the French IGN in 1996 is used to convert height above WGS84 spheroid into normal heights above MSL. (at *Al Hudaydah (MSL)* – Ed.). The geoid model software is available at **TOTAL** office.”

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