

Grids & Datums

SULTANATE OF OMAN

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

The Persian Gulf lies between two of the major breadbaskets of the ancient world, the Tigris-Euphrates area (Mesopotamia, meaning “between the rivers”) in present-day Iraq and the Nile Valley in Egypt. Mesopotamia, a part of the area known as the Fertile Crescent, was important not only for food production but also for connecting East to West. Mesopotamia became the linchpin of ancient international trade. The fertile soil between the Tigris and the Euphrates produced a large surplus of food; however, it did not support forests to produce the timber necessary to build permanent structures. The region also lacked the mineral resources to make metals. Accordingly, the early inhabitants of Mesopotamia were forced to go abroad and trade their food for other raw materials. They found copper at Magan, an ancient city that lay somewhere in the contemporary state of Oman and, via Magan, traded with people in the Indus Valley for lumber and other finished goods. The people of Magan were both middlemen and suppliers because the city was a source of copper as well as a transit point for Indian trade. Over time, other cities developed that were exclusively entrepôts, or commercial way stations. One of the best known of these cities was Dilmun. Dilmun probably lay on what is now the island state of Bahrain. Excavations on the island reveal rich burial mounds from the Dilmun period (ca. 4000 to 2000 B.C.). The area that constitutes the present-day Persian Gulf states was on the immediate periphery of the rise of Islam. In A.D. 610, Muhammad — a merchant of the Hashemite branch of the ruling Quraysh tribe in the Arabian town of Mecca — began to preach the first of a series of revelations that Muslims believe was granted him by God ... Shia Muslims hold the fundamental beliefs of other Muslims. In addition to these tenets, however, Shia believe in the imamate, which is the distinctive institution of Shia Islam. The term *Kharijites* also became a designation for Muslims who refused to compromise with those who differed from them. Their actions caused the Sunni community to consider them assassins. In the eighth century, some Kharijites began to moderate their position. Leaders arose who suppressed the fanatical political element in Kharijite belief and discouraged their followers from taking up arms against Islam’s official leader. Kharijite leaders emphasized instead the special benefits that Kharijites might receive from living in a small community that held high standards for personal conduct and spiritual values. One of these religious leaders, or imams, was Abd Allah ibn Ibad, whose followers founded communities in parts of Africa and southern Arabia. Some of Abd Allah’s followers, known as Ibadis, became the leaders of Oman” (*Library of Congress Country Studies*).

The Sultanate is bordered on the west by Saudi Arabia (676 km), United Arab Emirates (410 km) (*PE&RS*, February 2001), Yemen (288 km) (*PE&RS*, August 2003), and on the north, east, and south by the Gulf of Oman and the Arabian Sea (2,092 km). The terrain is comprised of a vast central desert plain with rugged mountains in the north and south. The lowest point is the Arabian Sea (0 m), and the highest point is Jabal Shams (2,980 m).

The only known classical geodetic datum in Oman is the Fahud Geodetic Datum of 1954, which was established by the Iraq Petroleum Corporation (IPC) for the Petroleum Development Oman (PDO) operation. Beginning in 1964, Hunting Surveys, Ltd., established an extensive control network based on the Fahud Datum of 1954, and this enterprise took over eight years to develop. Although the work was performed to a 3rd Order geodetic accuracy specification, the operational demands of a production oil field precluded the rigorous adjustment of the network. As a result, the classical network retained a number of relatively high distortions of up to 10 meters in magnitude for horizontal coordinate positions and up to 5 meters in elevation! A major Doppler satellite campaign was observed between September 1983 and August 1984. During this period, 106 existing stations in the Fahud Datum of 1954 network were occupied and observed. Subsequent to the initial period of survey work in Oman, all survey stations to the north of latitude 22° were given the prefix “NO,” and those to the south the prefix “SO.” This numbering system was later extended into the province of Dhofar, where the prefix “D” is used instead. The Fahud Datum of 1954 uses the Clarke 1880 as its ellipsoid of reference where: $a = 6,378,300.782$ m, and $1/f = 293.4663077$. The origin point of the Fahud Datum is near station “NO68-024” where the Astronomical Latitude, $\Phi_0 = 22^\circ 17' 31.182''$ North, and the Astronomical Longitude, $\Lambda_0 = 56^\circ 29' 18.820''$ East of Greenwich. The original astronomical origin point at F.N. Fort (station “F1” with defining azimuth to station “F2” of the baseline) has been destroyed. The baseline was located on a gravel plain on the southern side of an airstrip constructed for the survey. A total of 32 stations were triangulated in Fahud, including F15 and F5, and 15 stations were triangulated in Natih, including N1. Original coordinates of the triangulation were published on the WWII Trucial Coast/Qatar Grid on the Cassini-Soldner projection. The Central Meridian, $\lambda_0 = +50^\circ 45' 41''$ E, the False Northing Latitude of Origin, $(\phi_{FN}) = 25^\circ 22' 56.5''$ N, and both the False Eastings and False Northings are 100 km. Of course, the scale factor at origin by definition is equal to unity. Also used in the region was the Mecca-Muscat Zone on the Lambert Conical Orthomorphic projection where the Central Meridian, $\lambda_0 = 45^\circ$ East of Greenwich, the Latitude of Origin, $\phi_0 = 23^\circ$ N, a Scale Factor at Origin, $m_0 = 0.99907$, and a False Easting, F.E. = 1,000 km at the Central Meridian. The Oman Transverse Mercator projection has a Central Meridian, $\lambda_0 = 54^\circ$ East of Greenwich, a Scale Factor at Origin, $m_0 = 0.9997$, and a False Easting, F.E. = 500 km at the Central Meridian. Notice the curious similarity in the digits used for the Scale Factor at Origin values for the Mecca-Muscat Lambert zone and the Oman Transverse Mercator belt — I’ll bet that’s not a coincidence.

“The astronomical observations were approximately located on a 25 km grid in order to provide control for relative gravity surveys. Six to ten pairs of circum-meridian observations and 8-13 pairs of time stars were generally observed for the astrofixes. By 1957, triangulation

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networks had been established in the Buraimi area, the Duqm/Huqf area, and in the vicinity of Fahud covering over 2 degrees of latitude between Dhank and Nihayda. After the completion of the initial survey, the IPC Photo survey section in Tripoli, Lebanon used February 1953 aerial photographs to produce a Fahud Topographical Map at a scale of 1:25,000 on the UTM grid. A subsequent geological map was cast on the Trucial Coast grid in July 1956.

“During 1964, a survey was conducted by the British Army Directorate of Military Survey (DMS), which involved a cantilevered Tellurometer traverse from Dubai in the United Arab Emirates through Buraimi to Fahud (Series 13B). The traverse, to extend available control, was carried out by 13 Field Survey Squadron, during April-May 1964. In 1964, Hunting Surveys, Ltd. was contracted by PDO to install new control by Tellurometer traversing for mapping and oil exploration purposes. The specification called for station intervals of about 20 km, with azimuth stations; and at each station, for 3 sets of simultaneous reciprocal vertical angles. Distances were to be observed in both forward and reverse directions with agreement better than 1/50,000. Polaris azimuths were to be observed at 100 km intervals. (This was amended to 60 km in later years). Closure between azimuths was specified to be less than 2” per station” (*M.H.B. Jensen, December 1984*).

The *original* Fahud Height Datum was based on reciprocal trigonometric heighting from a single MSL determination at Mina al Fahal (formerly known as Saih al Maleh) in Muscat. Station NO68-024 had an orthometric height of 323.50 m above mean sea level at Mina al Fahal. *According to the Ordnance Survey of Great Britain*: “PDO Height Datum of 1993 - Misclosure between Muscat and Salalah less than .5 meters with differences from of up to 5 meters from old Fahud Datum. The PHD93 adjustment was initially known as the Spine (*sic – Ect*). Supercedes Fahud Vertical Datum from 1993.”

The transformation **from** WGS84 Datum **to** PDO Survey Datum 1993 listed by Wilfred of Medco Energy in 2005 is: $\Delta X = +180.624$ m, $\Delta Y = +225.516$ m, $\Delta Z = -173.919$ m, $\delta S = -16.71006$ ppm, $R_x = -0.80970$ ”, $R_y = -1.89755$ ”, $R_z = +8.33604$ ”. No information was offered regarding transformation accuracy nor the sense of the coordinate system rotations, but fortunately a test point was provided where: PSD93 (Clarke 1880) $\phi = 20^\circ 20' 56.967$ ” North, $\lambda = 56^\circ 31' 15.467$ ” East and WGS84 $\phi = 20^\circ 20' 58.495$ ” North, $\lambda = 56^\circ 31' 25.456$ ” East.

While researching Oman, I noticed that the Honorable Gary A. Grappo is currently the United States Ambassador to the Sultanate of Oman. Ambassador Grappo holds a Masters Degree in Geodesy from Purdue University.



The contents of this column reflect the views of the author, who is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the American Society for Photogrammetry and Remote Sensing and/or the Louisiana State University Center for Geoinformatics (C⁴G).