The original peoples of what is now Angola were probably Khoisan speaking hunters and gatherers (bushmen). During the first millennium AD, large-scale migrations of Bantu speaking people moved into the area and eventually became the dominant ethno-linguistic group of southern Africa. The most important Bantu kingdom in Angola was the Kongo, with its capital at Mbanza Kongo (called São Salvador do Congo by the Portuguese). South of the Kongo was the Ndongo kingdom and its ruling family, and engaged in trade and missionary work. By the early 17th century, some 5,000+ explorers reached Angola, Christianized the indigenous people, and produced a storm of protests in Europe, and Portugal proposed a conference on the Congo that resulted in the Berlin Conference held between November 15, 1884 and February 26, 1885. Consider then, that the borders of Cabinda are in common with Congo (Brazzaville), which was part of the former Congo Français (French Congo), and is currently the Republic of the Congo. The southern border is in common with Congo (Kinshasa), once the Belgian Congo, later called Congo, then Zaïre, and currently the Democratic Republic of Congo. The controlling classical datum for southern Africa and most surrounding countries of Angola proper is the Arc Datum of 1950 whose point of origin is station Buffelsfontein where $\Phi = 33^\circ 59' 32.00''$ South, $\lambda = 25^\circ 30' 44.622''$ East of Greenwich, and the azimuth from south to station Zuurburg is $\alpha = 183^\circ 58' 15''$. The reference ellipsoid for the Arc 50 Datum is the Clarke 1880 with semi-major axis $a = 6,378,249.145$ m and the reciprocal of flattening $1/f = 293.465$. Angola’s southern border is with that country once called German Southwest Africa, and Namibia is the only country in the African continent to utilize the Bessel 1841 ellipsoid for its Schwarzeck Datum where, for Namibia, the semi-major axis $a = 6,377,483.865$ International meters and the semi-minor axis $b = 6,356,165.383$ International meters. Values actually used in Namibia are $a = 6,377,483.865$ legal meters and $1/f = 299.1528128$. The origin point is Schwarzeck, near Gobabis, where $\Phi = 22^\circ 45' 35.820''$ South, and $\lambda = 18^\circ 40' 34.549''$ East of Greenwich. (Our Paul M. Hebert School of Law here at Louisiana State University is helping build a Law Library at the University of Namibia).

The earliest geodetic observation in Angola is to the 1884 meridional distance from the mid-Atlantic island of St. Helena to Baie dos Elefantes (Elephant Bay) in Angola and thence north to São-Paulo de Loanda (Luanda). This revealed a probable error between 6° and 6½° in longitude in the existing Portuguese charts. This error was again reported in 1888 in a “Hydrographic Note” using meridional distances from Cape Town Observatory to the two ports mentioned above and to Moçãmedes. In 1891, Annales Hydrographiques of the French Navy published the telegraphic determination of longitudes for three sites in Angola as determined by Commander Pullen of the Royal English Navy. Those determinations were São-Paulo de Loanda – at the pavilion slab of the Fort of San Miguel – where $\Phi = 08^\circ 48' 24''$ South, $\lambda = 10^\circ 53' 05''$ East of Paris, Benguela – at the Bureau Télégraphique ( Telegraph Office) – where $\Phi = 12^\circ 34' 43''$ South, $\lambda = 11^\circ 03' 40''$ East of Paris, and Moçãmedes – at the pavilion slab of Ponta da Noronha – where $\Phi = 12^\circ 34' 43''$ South and $\Phi = 11^\circ 03' 40''$ East of Paris.

In 1918, the Portuguese authorities established a new position for Luanda Observatory and supplied details of the triangulation of that area. “A Missão Geográfica de Angola criada na …,” “The Geographic Mission of Angola was cre-
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...established in the province in 1921 to establish a geodetic net in order to provide for a cartographic survey of the territory; after more than three campaigns, when it was dissolved, the Mission had surveyed two arcs of triangulation – one from Benguela to Huambo and the other along the” (meridian) “14° 00’ East of Greenwich from adjacent figures to Lubango. Subsequently, for geodetic operations, a hydrographic mission, which had campaigns from 1930 to 1933, established geodetic figures along the Zaire (Congo) River with common vertices with the Congo (Kinshasa) Triangulation, and executed a geodetic base with astronomical observations for latitude in eight stations, for longitude in five stations, and two for azimuth. Furthermore, the systematic and regular occupation of geodetic points in the province was initiated in the beginning of 1941 as an actual activity of the Geographic Mission of Angola.

The instructions were formulated by the “Junta de Investigações do Ultramar” (Overseas Research Commission) of which the following points, with respect to the geodetic activities, were

1. complete the geodetic coverage of the province, including the principal triangulation figures and the secondary triangulation, first to involve two arcs of the meridian and the parallel at a 2° interval, and second, to densely adequately for cartographic operations at comprehensive spaces in the principal triangulation figures;

2. establish geodetic bases at distances of about 400 km along principal figures, and provide for the distribution that forms a precision of European second-order triangulation – which is a precision less than attributed to the principal triangulation;

3. observe Laplace stations at 200- km by 200-km spacings;

4. obtain the following precision for the geodetic and astronomical observations as principal triangles – 6", secondary triangles – 10", latitude – 0.2", longitude – 0.5", and azimuth – 0.5°.” To paraphrase, the Chief of the Geographic Mission later sent instructions in 1946 to observe arcs of the meridian and the parallel at a multiple interval of 3°. In 1953, the first order triangulation was adjusted using tables from the U.S. Coast and Geodetic Survey (based on the Clarke 1866 ellipsoid). “This adjustment was based on the condition equations formed by 269 triangles.”

The triangulation eventually comprised 17 bases at Quimongo, Congo Yala, Quitinda, Luanda, Lucala, Camacupa, Catumbela, Alto Catumbela, Cimo, Serpa Pinto, Quipungo, Moçâmedes, Humbe, Baia dos Tigres, Sare, Namatuco, and Luiana – determined 1722 points based on observations of 3809 triangles of which 856 points were not occupied – made astronomical observations of latitude, longitude, and azimuth at 15 station – and performed the leveling of 943 km.

Immediately prior to WWII, the Belgians published booklets in French and Flemish, listing the coordinates and geodetic positions for Bas-Congo that extended from the Atlantic Ocean to Leopoldville. In those booklets are some 38 points that are referred to the Congo-Yella Datum. Some of those points are Portuguese control points common with Angola that shares the river. The fundamental point for the Congo-Yella Datum is the east base terminal of Congo-Yella where \( \Phi_0 = 06° 00’ 53.139” \) South, \( \lambda_0 = 12° 58’ 29.287” \) East of Greenwich, and the ellipsoid is Clarke 1880. Transformation parameters from the Congo-Yella Datum to the Angola Datum (also Clarke 1880) are \( \Delta X = -35.08 \) m, \( \Delta Y = +184.83 \) m, and \( \Delta Z = +63.02 \) m (±3.7 m); and from Congo-Yella Datum to the Camacupa Datum of 1948 are \( \Delta X = -44.47 \) m, \( \Delta Y = +179.47 \) m, and \( \Delta Z = +59.30 \) m (±2.0 m). The similarity of values gives confirmation that, in this region, the Angola Datum is equivalent to the Camacupa Datum of 1948. From the Congo-Yella Datum to the WGS 84 Datum, \( \Delta X = -93.28 \) m, \( \Delta Y = -164.11 \) m, and \( \Delta Z = -169.02 \) m (±5 m). Grids based on the Congo-Yella Datum are the Belgian Congo Gauss-Krüger Transverse Mercator

*Photo: Fuseau 13 (Zone 13) where latitude of origin \( \phi_0 = 2° 30’ \) South, Central Meridian \( \lambda_0 = 13° \) E, FN = 700 km, FE = 220 km, and the scale factor \( (m_0) = 1.0 \); Fuseau 14 where latitude of origin \( \phi_0 = \) Equator, Central Meridian \( \lambda_0 = 14° \) E, FN = 10,000 km, FE = 500 km, and the scale factor \( (m_0) = 0.9999 \); and Fuseau 16 where latitude of origin \( \phi_0 = \) Equator, Central Meridian \( \lambda_0 = 16° \) E, FN = 10,000 km, FE = 500 km, and the scale factor \( (m_0) = 0.9999 \). The Gabon Belt (Fuseau Gabon) is found in use along the northern coast (PEERS, September 1998). Of course, the UTM grid is common in Angola.

The Camacupa Datum of 1948 is based on the origin at Campo de Aviação where \( \Phi_0 = 12° 01’ 19.070” \) South, \( \lambda_0 = 27° 19.800” \) East of Greenwich, and \( h_0 = 1508.3 \) m. Thanks to John W. Hager, “This is the principal vertex marked by a concrete monument, constructed on a high part of the Camacupa Air Field, immediately to the north of the runways.” (This is) “defined as the “Datum Point” of the main triangulation network of Angola. A concrete monument with the dimensions 70 × 60 × 100 cm (length E-W × width N-S × height), topped by a white marble slab on which is cut in black: M.G.A. · -P.F.- 1948; in the center of which is placed the top mark of the base, which is defined as the extreme West of the Geodetic Base of Camacupa. The mark found here is protected by a masonry casing with a metallic cover, easily removed to permit observations over the base when necessary.” Remarkably, some Datums established by the Portuguese in Angola (and Moçambique) were referenced to the Clarke 1866 ellipsoid

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(the same as used in the U.S. for the North American Datum of 1927) where \( a = 6,378,206.4 \text{ m} \) and \( b = 6,356,583.8 \text{ m} \). The only transformation parameters I have ever been able to scrounge from this Datum to WGS84 were obtained from Prof. Charles L. Merry at the University of Cape Town where \( \Delta X = -49 \text{ m}, \Delta Y = -301 \text{ m}, \) and \( \Delta Z = -181 \text{ m} \) and Prof. Merry estimates the accuracy at ±60 meters. According to Hager, “sometime in the 1960s or 1970s, DMA was asked to put Angola, then on the Camacupa Clarke 1866 Datum, on the Camacupa Clarke 1880 and the Arc 50 Datums. The Portuguese provided all the coordinates based on the Clarke Datum. They also provided tables to convert from the Clarke 1866 Datum to the Clarke 1880 Datum assuming that the tangent point of the two ellipsoids was at Camacupa. I think that the tie was on the 12th Parallel South to the Zambian Triangulation. (It was). The 6th Parallel south and Bas Congo surveys of Congo occupy common points with the Angola surveys and were adjusted to the Arc Datum of 1950. A comparison of the Angola values showed that Arc 50 Datum in Angola was adequate for mapping purposes. Angola is on the UTM Grid. I did find a local grid for Luanda and would expect other similar ones. For Luanda, the 1,200-scale city map plots directly on top of the UTM Grid of the 1:100,000-scale map. The 50,000 50,000 intersection is, in UTM coordinates, \( N = 9,024,000 \) and \( E = 306,000 \). This then results in a local Grid, Transverse Mercator projection, Clarke 1880 ellipsoid, \( \phi_0 = 0^\circ, \lambda_0 = 15^\circ \text{ E}, FN = 1,026 \text{ km}, FE = 244 \text{ km}, \) and \( (m) = 0.9996 \). The UTM scale factor at local 50,000 50,000 is 1.00006581. A unity scale factor was expected for a City Grid, and this is pretty close to unity. The math for the false coordinates is \( FN = 10,000,00 - 9,012,00 + 50,000 = 1,026,000 \) and \( FE = 500,000 - 306,000 + 50,000 = 244,000. \) The Camacupa Clarke 1880 Datum is oftentimes referred to by the hydrographic community as the Camacupa-Vumatumba Datum of 1950 based on the origin surveyed by MHCA in 1950 as \( \Phi = 06^\circ 26' 17.111'' \text{ South and } \lambda = 12^\circ 27' 22.978'' \text{ East of Greenwich. Transformation parameters used by Western Geophysical from the Camacupa-Vumatumba Datum of 1950 to the WGS 84 Datum are: } \Delta X = -39.44 \text{ m}, \Delta Y = -353.66 \text{ m}, \Delta Z = -224.16 \text{ m}, \) and the transformation parameters used by the British Navy are \( \Delta X = -48.81 \text{ m}, \Delta Y = -343.58 \text{ m}, \Delta Z = -228.32 \text{ m}, \pm 10 \text{ meters for the northern part of the country.} \) Thanks to parameters published into the public domain by the European Petroleum Studies Group (EPSG) headed up by Mr. Roger Lott of British Petroleum, there are a number of transformations from the Clarke 1880 version of the Camacupa Datum of 1948. For instance, Camacupa 1948 to WGS 72BE: \( \Delta X = -37.2 \text{ m}, \Delta Y = -370.6 \text{ m}, \) and \( \Delta Z = -228.5 \text{ m}; \) this was derived by Geophysical Services, Inc. in 1979. Camacupa 1948 to WGS84, used by Conoco for Offshore Block 5: \( \Delta X = -42.01 \text{ m}, \Delta Y = -332.21 \text{ m}, \) and \( \Delta Z = -229.75 \text{ m. Camacupa 1948 to WGS84 and used by Topnav at PAL F2, by Elf in blocks 3 and 17 since 1994, and by Total in block 2 since 1994: } \Delta X = -50.9 \text{ m, } \Delta Y = -347.6 \text{ m, and } \Delta Z = -231 \text{ m. An additional eight versions of parameters are used for the “same” transformation in offshore areas spanning the entire coast of Angola.} \) The MHAST Datum of 1951 (Missão Hidrográfica de Angola e São Tomé) fundamental point is a concrete block, point \( Y, \) at Malongo light-house that is at \( \Phi = 05^\circ 23' 30.81'' \text{ South, } \lambda = 12^\circ 12' 01.59'' \text{ East of Greenwich, and is referenced to the International ellipsoid of 1924 where } a = 6,378,388 \text{ m and } 1/f = 297. \) From MHAST to WGS84: \( \Delta X = -252.95 \text{ m}, \Delta Y = -4.11 \text{ m, and } \Delta Z = -96.38 \text{ m. } \) The Malongo Datum of 1987 replaced the MHAST Datum of 1951, and is also referenced to the same fundamental point (new coordinates unknown). The same ellipsoid is used; however, the transformation parameters have changed to become Malongo 1987 Datum to WGS 84: \( \Delta X = -254.10 \text{ m, } \Delta Y = -5.36 \text{ m, and } \Delta Z = -100.29 \text{ m, thanks to Mal Jones of Perth, Australia.} \) Hager went on to say; “A survey was done across Congo (Kinshasa) connecting Angola proper to Cabinda but the data were destroyed by a fire in Lisbon so Cabinda is on a local datum. About all the booklet for Cabinda will say is that it is not on Camacupa 1948 Datum. The values of the boundary marks in the northwest of Cabinda are in agreement with those published by (the French) IGN and used by Congo (Brassaville).” Other datums existing in Angola include the Lobito Datum of 1937 based on the origin point at the astronomical pillar Restinga do Lobito, Extremo NE da Base do Lobito, where \( \Phi = 12^\circ 19' 00.86'' \text{ South, } \lambda = 13^\circ 34' 45.67'' \text{ East of Greenwich, } \) Clarke 1866 ellipsoid. Dr. José Carvalho of Maputo, Moçambique states that the Camacupa Datum of 1948 coordinates of the same point are \( \Phi = 12^\circ 19' 01.357'' \text{ South, } \lambda = 13^\circ 34' 58.375'' \text{ East of Greenwich. The transformation from the Lobito 1937 Datum to the WGS 84 Datum is } \Delta X = -256.73 \text{ m, } \Delta Y = 0.00 \text{ m, and } \Delta Z = -103.67 \text{ m (±10 m).} \) The Luanda Datum is based on the origin point at Luanda Observatory where \( \Phi = 08^\circ 48' 46.8'' \text{ South, } \lambda = 13^\circ 13' 21.8'' \text{ East of Greenwich, } \) Clarke 1866 ellipsoid. The Moçamedes Datum of 1956 origin point is at the Moçamedes Meteorological Station where \( \Phi = 15^\circ 11' 16.34'' \text{ South, } \lambda = 12^\circ 07' 34.53'' \text{ East of Greenwich, } \) Clarke 1866 ellipsoid. Many thanks to Sequoia Read of the Defence Geographic Centre and the Geodesy Section of the United Kingdom Hydrographic Office.