According to Lonely Planet, “South Africa’s history extends back to around 40,000 BC when the San people first settled Southern Africa. By AD 500, Bantu-speaking peoples had arrived from West Africa’s Niger Delta. Competing colonial European powers began settling here in small numbers from the 17th century, mostly in the Cape. Widespread colonial settlement of South Africa began in the 19th century. From 1836, groups of Boers dissatisfied with British rule in the Cape Colony trekked off into the interior in search of freedom. In a decade of migration known as the Great Trek, increasing numbers of Voortrekkers (fore-trekkers – pioneers) abandoned their farms and crossed the Senqu (Orange) River. Reports from early missions told of vast, uninhabited – or at least poorly defended – grazing lands. Tensions between the Boers and the government had been building for some time, but the reason given by many trekkers for leaving was the 1833 act banning slavery. The Great Trek coincided with the difaqane (forced migration) and the Boers mistakenly believed that what they found – deserted pasture lands, disorganized bands of refugees and tales of brutality – was the normal state of affairs. This gave rise to the Afrikaner myths that the Voortrekkers moved into unoccupied territory or arrived at much the same time as black Africans. The Great Trek’s first halt was at Thaba ‘Nchu, near present-day Bloemfontein, where a republic was established. Following disagreements among their leadership, the various Voortrekker groups split, with most crossing the Drakensberg into Natal to try and establish a republic there. As this was Zulu territory, the Voortrekker leader Piet Retief paid a visit to King Dingaan, and was promptly massacred by the suspicious Zulu. This massacre triggered others, as well as a revenge attack by the Boers. The culmination came at the Battle of Blood River in 1838 in Natal. While the Boers sustained some injuries, more than 3,000 Zulu were killed, reportedly causing the Ncome River to run red.”

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sides could claim some of the success in achieving this historic goal, both sides also faced even greater challenges in trying to establish a stable multiracial society in the decades ahead” (U.S. Dept. of State, Country Studies, 2012).

Slightly less than twice the size of Texas, South Africa is bordered by Botswana (1,840 km) (PE&RS, May 2004), Lesotho (909 km) (PE&RS, June 2008), Mozambique (491 km) (PE&RS, September 1999), Namibia (967 km) (PE&RS, August 2006), Swaziland (430 km), and Zimbabwe (225 km) (PE&RS, November 2003). The terrain is comprised of a vast interior plateau rimmed by rugged hills and narrow coastal plain; the lowest point is the Atlantic Ocean (0 m), and the highest point is Njesuthi (3,3408 m). (World Factbook, 2012).

“The pursuit of the figure of the earth has a long and interesting history in South Africa. The year 2001 marked the 250th anniversary since the prominent astronomer-geodesist Abbe de LaCaille set foot on South African soil to catalogue the Southern stars by their celestial co-ordinates of right ascension and declination. Shortly after his arrival at the Cape, LaCaille set out to measure a meridian of arc in the southern hemisphere as no such measurement existed. Abbe de LaCaille measured a triangulation arc northwards from Cape Town, to determine the figure of the earth and obtained a result which indicated that the curvature of the earth was less at southern latitudes than at corresponding northern ones. This perplexity was later to be verified by Sir Thomas Maclear, Her Majesty’s Astronomer at the Cape. Sir George Everest visited the Cape in 1820 and inspected the site of LaCaille’s meridian arc. His experience in the Himalayas led him to believe that the presence of considerable mountain masses in the Cape could have caused some anomalous disturbance thus falsifying the astronomical latitude determinations made by LaCaille. Sir Thomas Maclear was tasked to verify LaCaille’s meridian arc and commenced such in 1840, completing the task in 1848. The arc was extended southward beyond the possible gravitational effect of William Morris. The field party set out to measure the Pietersmaritzburg base, which was then extended by triangulation to the geodetic chain. The geodetic chain later was extended northwards towards Newcastle. The chain was carried south-west from Pietersmaritzburg to Port Elizabeth, then northwards from Port Elizabeth to Kimberly. These geodetic operations were completed before the Anglo-Boer War of 1899-1902, after which the work was extended over the Orange Free State and Transvaal up to the former Rhodesia where the 30th meridian also commenced also under the instruction of Sir David Gill. Astronomical observations of latitude and longitude were made at frequent intervals in order to position the geodetic chains on the earth, and azimuth observations to orient the work to the earth’s axis of rotation. Sir David Gill had taken great care in choosing a datum point free of ‘considerable deviation of the plumb-line’ for the geodetic survey. Differences between astronomical and geodetic measurements showed that his triangulation on the datum and the chosen Clarke 1880 ellipsoid was in good agreement with the figure of the earth in South Africa. From the 1920’s onward the Trigonometrical Survey undertook extensive geodetic surveys. In the mid 1930’s the Kaitob base and the Mtubatuba base were measured. Land Surveyor, H. S. K. Simpson played a key role in these surveys. These were the last of the taped baselines before the advent of the EDM (electromagnetic distance measurement). (Note that the Tellurometer EDM was invented and manufactured in South Africa – Ed.). Recent additions to the geodetic framework include a looped chain of triangulation passing through the Mtubatuba baseline which was attached to the northern Natal section of the 30th meridian. The northern Transvaal section of the 30th meridian arc was extended eastwards toward the Mozambican border; a loop of geodetic triangulation running parallel to the Botswana border was attached to the western side of the 30th meridian arc. In the northern Cape, Surveyors Leipoldt and Heatlie connected the northern end of Maclear’s arc to the Port Elizabeth-

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conducted a minor triangulation based on the geodetic survey of the Orange Free State. By 1919 a considerable amount of trigonometrical control became available for cadastral and mapping purposes. New concrete beacons were built over the old centre points, points were re-observed and co-ordinates were recomputed in the Gauss Conform system. This revision was initiated in 1919 by the newly appointed Director of Trigonometrical Survey, Willem Cornelis van Der Sterr. The present structure housing the Chief Directorate: Surveys and Mapping is named after him. The Primary triangulation scheme continued under the direction of Van Der Sterr and computations were carried out in Mowbray under the watchful eyes of geodesist Oscar Schreiber. Primary order triangulations of 40 km sides were reconnoitred to fill the open spaces encircled by the loops of geodetic chains. The interpolation followed into the primary points of the secondary order triangulation nets. Thereafter, the tertiary stations followed with these points being intersected by rays observed to and from the surrounding fixed secondary stations. Sub-tertiary intersections were conducted in urban areas, often to church spires, in order to provide control for street traverses which connect the underground reference marks placed at street intersections and upon which urban surveys are based. This highlights the description of the unified trigonometrical system upon which all mapping, cadastral and engineering surveys are based” (Chief Directorate: Surveys & Mapping, Dept. of Land Affairs, Mobray, Cape Town, South Africa, 2001).

Thanks to John W. Hager, the classical geodetic origin of the Cape Datum/Arc 1950 Datum is at Buffelsfontein (in Port Elizabeth) where: \( \Phi_o = 33^\circ 59' 32.000'' \text{ S}, \lambda_o = 25^\circ 30' 44.622'' \text{ E}, \) azimuth to Zuurberg measured from South: \( \alpha_o = 183^\circ 58' 15.00'' \), \( \xi = -3.46'' \), \( \eta = -0.59'' \), \( h_o = 280.1 \text{ m} \), and the ellipsoid of reference is the Clarke 1880 where: \( a = 6,378,249.145 \text{ m} \), and \( f = 293.465 \). The Gauss Conform Transverse Mercator Grid system has 2º wide central meridians at: 17ºE, 19ºE, …, 31ºE, 33ºE.

“No arbitrary scale factors or false origins are applied to the co-ordinates; X is measured positive southwards from the equator and Y positive westwards from the nearest odd meridian. The unit of measurement since the 1970’s is the International metre” (Chief Directorate: Surveys and Land Information, 1995, personal communication).

The new geodetic datum in South Africa is termed “Hartbeeshoek 94 Datum” and is referenced to the GRS80 ellipsoid where: \( a = 6,378,137. \text{ m} \), and \( f = 298.257222101 \). The 3-parameter transformation from Cape Datum to Hartbeeshoek 94 Datum is where:

\[
\Delta X = +134.7 \text{ m}, \quad \Delta Y = +110.9 \text{ m}, \quad \Delta Z = +292.7 \text{ m} \quad \text{(op.cit. Chief Directorate, 1995).}
\]

High-accuracy transformations are available from the Chief Directorate: Surveys and Land Information in the form of software that operates in somewhat similar fashion to the NADCON package of the U.S. National Geodetic Survey. The government of South Africa has also developed a high-accuracy geoid model for their country, and a GPS Real Time Network provides full-country coverage for high precision surveys.

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).