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

Originally populated by aborigines who probably came from Asia about 40,000 years ago, Australia was first sighted by the Spanish in the early 17th century. In 1606, the Dutch landed on the eastern coast of the Bay of Carpentaria and named it New Holland. The eastern part was claimed by Capt. James Cook in 1770 and named New South Wales. The first English settlement at Port Jackson was mainly populated by convicts and seamen in 1788.

Capt. Matthew Flinders circumnavigated Australia from 1801-1803 and exhibited a level of professionalism not previously seen in the hydrographic charting expeditions of others in the British Admiralty, such as Vancouver. Capt. Flinders received his initial instruction in navigation and chart making as well as tongue-lashings by Capt. William Bligh of the Bounty during the successful breadfruit voyage from Tahiti to the Caribbean. It was on that early voyage that Capt. Flinders was in charge of the navigation chronometers. (*The Admiralalty Chart* by RADM G. S. Ritchie, 1995.)

Capt. Flinders proved the continental unity of New Holland and New South Wales. Named Australia in the 19th century, the entire continent was claimed by the United Kingdom (*PE&RS*, October 2003) in 1829. The continent of Australia is slightly smaller than the United States; the lowest point is Lake Eyre (−15 m), and the highest point is Mount Kosciusko (2,229 m). The *CIA Factbook* describes the country as mostly low plateau with deserts; fertile plain in southeast and having a generally arid to semiarid climate that is temperate in the south and east; tropical in the north. A further note points out that Australia is the ‘world’s smallest continent but sixth-largest country; population concentrated along the eastern and southeastern coasts; regular, tropical, invigorating, sea breeze known as ‘the Doctor’ occurs along the west coast in the summer.”

The first astronomical “fix” or precise position determination along the coast of southern Australia was by Capt. Flinders in 1801 when he wrote: “The latitude of our tents at the head of Port Lincoln, from the mean of four meridian observations of the Sun taken from an artificial horizon was 34° 48’ 25” S. The longitude from thirty sets of distances of the sun (sic) and stars from the moon was 135° 44’ 51” E. – (Ritchie, 1995). The enormous size of the country and the fact that this continent is surrounded by water has resulted in many local datums being established in coastal areas and little early geodetic work in the vast interior. Among those lesser datums known to exist on the Clarke 1858 ellipsoid are: Adelaide Observatory, Astro Fixation Western Australia 21, Army OP LA22 Lacrosse Island, Valentine, Australian Pillar, Central Origin 1963, Cookes Pillar Broome, Townsville, Emery Point Lighthouse, Final Sydney 1941, Gladstone Observatory Spot, Old Sidney, Maurice 1962, Melbourne Observatory, Weipa Mission Astro, Mildura Aerodrome, Mt. Rapid Fleurien Peninsula, Plantation Point...
Jervis Bay, Point Langdon South Base, Groote Eylandt, Port Huon Hospital Bay Observation Spot, New South Wales, New Sidney, and Mount Campbell.

Prior to the Australian Geodetic Datum of 1966, the Clarke 1858 ellipsoid as used in Tasmania was \( a = 6,378,293.645 \) meters and \( 1/f = 294.26 \) and in Australia proper was \( a = 6,378,339.78 \) meters and \( 1/f = 294.26 \). The difference between the two was the Clarke foot = 0.3047972654 meters versus the British foot of 1926 = 0.304799474 meters. Of the earlier more important datum origins, there were: Sydney Observatory where: \( \Phi_o = 33^\circ 51´ 41.10^\prime S \) and \( \Lambda_o = 151^\circ 12´ 17.85^\prime E \), Perthen Observatory 1899 where: \( \Phi_o = 31^\circ 57´ 09.63^\prime S \) and \( \Lambda_o = 115^\circ 50´ 26.10^\prime E \), Darwin Origin Pillar where: \( \Phi_o = 12^\circ 28´ 08.452^\prime S \) and \( \Lambda_o = 130^\circ 50´ 19.802^\prime E \), and Lochmaben Astro Station in Tasmania where: \( \Phi_o = 41^\circ 38´ 23.389^\prime S \) and \( \Lambda_o = 147^\circ 17´ 49.725^\prime E \). The astronomical longitudes differed from geodetic longitudes on either the Sydney or Perth origins on an average of 10\(^\prime\), which indicated the magnitude of the deflections of the vertical.

During the 1930s, the Australia Belts were devised on the Transverse Mercator projection. Referenced to the Clarke 1858 ellipsoid, and an ersatz military datum, the scale factor was equal to unity; the belts were numbered from 1 to 8 and were 5º wide, starting with a central meridian at 116º and continuing east. Each belt had a false Easting at the central meridian of 400,000 yards, and the False Northing origin was 800,000 yards at 34º S. A caveat published by the U.S. Lake Survey, New York Office in 1944 cautioned: "If these origins, some 1:250,000 maps were based on these origins, some 1:250,000 maps were based on the Central meridian: S 25º 54´ 11.078˝, E 134º 30´ 25.110˝. The Central origin was based on the best mean fit to 155 Laplace stations spread over the whole of Australia with the exception of Cape York and Tasmania. The residual mean deflection was less than 0.1” in both latitude and longitude whether isostatic topographic corrections were applied to the astronomical values or not. It was therefore considered unlikely that there was a significant artificial component in N with the Central origin. As no observed values of N from geoid surveys existed, it was assumed that N is everywhere zero. ("N here refers to the separation between the geoid and the ellipsoid – Ed.)" In April 1965, it was changed to the spheroid adopted by the International Astronomical Union and this spheroid was called the Australian National Spheroid: \( a = 6,378,160 \) m, and \( 1/f = 298.25 \). In May 1965 a complete recomputation of the geodetic surveys of Australia was begun, emanating from the trigonometrical station Grundy, whose coordinates on both the 165, Central datum and the Australian National Spheroid, Central origin were: S 22º 51´ 1.341˝, E 138º 30´ 42.29˝, and Astronomic: S 22º 51´ 11.341˝, E 138º 30´ 25.110˝. The Central origin was used with the NASA spheroid was retained. As a result of these recomputations, new origin values were determined and from April 1963 to April 1965, computations were made on the 165 spheroid and this new 'Central' origin. Computations still emanated from Maurice whose various coordinates were: 165 Central: S 32º 51´ 13.979˝, E 138º 30´ 34.062˝, 165 Maurice: S 32º 51´ 13.000˝, E 138º 30´ 34.000˝, Clarke 1858, Sydney: S 32º 51´ 11.482˝, E 138º 30´ 42.29˝, and Astronomic: S 32º 51´ 11.341˝, E 138º 30´ 25.110˝. The Central origin was based on the best mean fit to 155 Laplace stations spread over the whole of Australia with the exception of Cape York and Tasmania. The residual mean deflection was less than 0.1” in both latitude and longitude whether isostatic topographic corrections were applied to the astronomical values or not. It was therefore considered unlikely that there was a significant artificial component in N with the Central origin. As no observed values of N from geoid surveys existed, it was assumed that N is everywhere zero. ("N here refers to the separation between the geoid and the ellipsoid – Ed.)"
The Geocentric Datum of Australia 1994 (GDA94) is the new Australian coordinate system, replacing the Australian Geodetic Datum (AGD). GDA is part of a global coordinate reference frame and is directly compatible with the Global Positioning System (GPS). It is the culmination of more than a decade of anticipation and work by the Intergovernmental Committee on Surveying and Mapping (ICSM) and its predecessor, the National Mapping Council (NMC). When the NMC adopted the AGD84 coordinate set in 1984, it ‘recognised the need for Australia to eventually adopt a geocentric datum.’ This was further recognised in 1988 when ICSM ‘recommended the adoption of an appropriate geocentric datum by 1 January 2000.’

The state of Western Australia has the “Project Grids” that closely correspond to what we use in the United States as an appropriate geocentric datum by 1 January 2000.

Datum shifts between the various classical datums and the various scientific reference frames of the GPS satellites are available for cartographic-accuracy transformations. However, for precise geodetic applications, the parameters change monthly because the entire continent is moving to the Northeast at about 3 centimeters per year! For instance, a couple of cartographic transform accuracy parameter sets are given as follows: From Australian Geodetic Datum 1966 (Victoria/New South Wales) to WGS84: ∆X = –119.353 m, ∆Y = –48.301 m, ∆Z = +139.484 m, Rx = –7.243 × 10–3 radians, Ry = –4.538 × 10–3 radians, Rz = –7.627 × 10–3 radians, and Δ = –6.13 × 10–1. From Australian Geodetic Datum 1984 to WGS84: ∆X = –117.763 m, ∆Y = –51.51 m, ∆Z = +139.061 m, Rx = –5.096 × 10–3 radians, Ry = –7.732 × 10–3 radians, Rz = –4.835 × 10–3 radians, and Δ = –1.91 × 10–1. Australia is a free and open society. Their geodesy is not a secret and their geodetic documents he has sent to me over the years.

Australia Update

Comprehensive information on upgrades to the Australian Geospatial Reference System can be found at: https://www.icsm.gov.au/upgrades-australian-geospatial-reference-system.

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 (CIG). This column was previously published in PE&RS.