Grids & Datums

COMMONWEALTH OF AUSTRALIA

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

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 mostly 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 Admirdalty 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 tropical in the north. A further note points out that this continent is surrounded by water has resulted in many local navigation and chart making as well as tongue-lashings by Capt. Flinders was in charge of the navigation chronometers. (The Admirdalty Chart by RADM G. S. Ritchie, 1995.)

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 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 Sidney 1941, Gladstone Observatory Spot, Old Sidney, Maurice 1962, Melbourne Observatory, Weipa Mission Astro, Mildura Aerodrome, Mt. Rapid Fleurien Peninsula, Plantation Point Jervis Bay, Port Langdon South Base, Groote Eylandt, Port Huon Hospital Bay Observation Spot, New South Wales, New Sydney, 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 = 0.30479947 meters. Of the earlier more important datum origins, there were: Sydney Observatory where: \( \Phi = 33° 51’ 41.10’’ S \) and \( \lambda = 151° 12’ 17.85’’ E \), Perth Observatory 1899 where: \( \Phi = 31° 57’ 09.63’’ S \) and \( \lambda = 115° 50’ 26.10’’ E \), Darwin Origin Pillar where: \( \Phi = 12° 28’ 08.452’’ S \) and \( \lambda = 130° 50’ 19.802’’ E \), and Lochmaben Astro Station in Tasmania where: \( \Phi = 41° 38’ 38.7389’’ S \) and \( \lambda = 147° 17’ 49.725’’ E \). The astronomical longitudes differed from geodetic longitudes on either the Sidney or Perth origins on an average of 10’, 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 erset military datum, the scale factor was equal to unity; the belts were numbered from 1 to 8 and were 5” wide, starting with a central meridian at 116° 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 34° S. A caveat published by the U.S. Lake Survey, New York Office in 1944 cautioned: “If these false coordinates are used, negative values will result in Tasmania.” The Clarke foot was implemented for this grid. A test point was published where: \( \phi = 39° 31’ 12.767’’ S, \lambda = 143° 27’ 46.321’’ E \), \( X = 631,629.24 \text{ yds}, Y = 126,892.94 \text{ yds} \).

The least squares adjustment of the Australian geodetic network performed in March 1966 used the Australian Geodetic Datum. This adjustment produced a set of coordinates which, in the form of latitudes and longitudes, was known as the Australian Geodetic Datum 1966 coordinate set (AGD66). The grid coordinates derived from a Universal Transverse Mercator projection of the AGD66 coordinates, used the Australian National Spheroid, and was known as the Australian Map Grid 1966 coordinate set (AMG66). New South Wales instituted the Integrated Survey Grid (ISG) where the projection was the Transverse Mercator truncated to the cubic terms since the belts were only 2” wide with a ¼ ” overlap. The scale factor at origin, \( m_0 = 0.99994 \), the False Easting (FE) = 300 km and the False Northing (FN) = 5,000 km at the equator. The central meridians \( \lambda_o = 141°, 141°, \text{ etc. to } 153° E \).

Thanks to Geomatics Australia, “While much early mapping was based on these origins, some 1,250,000 maps were based only on astronomical observations with an accuracy of the order of 100 metres or more, or by a mixture of astro and conventional surveying. A comparison of coordinates based on different origins of this kind will include differences due to the uncertainty of the astronomical observation as well as the deflections of the vertical and could show differences of several hundreds of metres.

For a short period in 1962, geodetic computations were performed on the so-called ‘NASA’ sphereoid with an origin at Maurice as below; but these computations were completely superseded.” \( a = 6,378,148 \text{ m}, 1/f = 298.3 \).

From the end of 1962 until April 1965, the computations and adjustment of the Australian Geodetic Survey was done on the ‘16S’ sphereoid: \( a = 6,378,165 \text{ m}, 1/f = 298.3 \). Prior to April 1963, the ‘Maurice’ origin used with the NASA sphereid was retained. As
a result of these computations, 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 ema-
rinated from Maurice which various coordinates were: 165 Central: S 32° 51’ 13.979”, E 138° 30’ 34.062”, 165 Maurice: S 32° 51’ 13.000”, E 138° 30’ 34.000”, Clarke 1858, Sydney: S 32° 51’ 11.482”, E 138° 30’ 42.29”, and Astronomic: S 32° 51’ 11.341”, E 138° 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 astronomic 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 25° 54’ 11.078”, E 138° 30’ 34.062”, 165 Maurice: S 32° 51’ 13.000”, E 138° 30’ 34.000”, Clarke 1858, Sydney: S 32° 51’ 11.482”, E 138° 30’ 42.29”, and Astronomic: S 32° 51’ 11.341”, E 138° 30’ 25.110”. The Central origin was therefore retained, but is now defined in terms of the Johnston memorial cairn. The Central origin was originally defined in terms of the trigonometrical station Grundy, whose coordinates on both the 165, Central datum and the Australian National Spheroid, Central origin were: S 25° 54’ 11.078”, E 138° 30’ 34.062”, 165 Maurice: S 32° 51’ 13.000”, E 138° 30’ 34.000”, Clarke 1858, Sydney: S 32° 51’ 11.482”, E 138° 30’ 42.29”, and Astronomic: S 32° 51’ 11.341”, E 138° 30’ 25.110”. The Central origin was therefore retained, but is now defined in terms of the Johnston memorial cairn. The Central origin was originally defined in terms of the trigonometrical station Grundy, whose coordinates on both the 165, Central datum and the Australian National Spheroid, Central origin were: S 25° 54’ 11.078”, E 138° 30’ 34.062”, 165 Maurice: S 32° 51’ 13.000”, E 138° 30’ 34.000”, Clarke 1858, Sydney: S 32° 51’ 11.482”, E 138° 30’ 42.29”, and Astronomic: S 32° 51’ 11.341”, E 138° 30’ 25.110”. The Central origin was therefore retained, but is now defined in terms of the Johnston memorial cairn. The Central origin was originally defined in terms of the trigonometrical station Grundy, whose coordinates on both the 165, Central datum and the Australian National Spheroid, Central origin were: S 25° 54’ 11.078”, E 138° 30’ 34.062”, 165 Maurice: S 32° 51’ 13.000”, E 138° 30’ 34.000”, Clarke 1858, Sydney: S 32° 51’ 11.482”, E 138° 30’ 42.29”, and Astronomic: S 32° 51’ 11.341”, E 138° 30’ 25.110”. The Central origin was therefore retained, but is now defined in terms of the Johnston memorial cairn. The Central origin was originally defined in terms of the trigonometrical station Grundy, whose coordinates on both the 165, Central datum and the Australian National Spheroid, Central origin were: S 25° 54’ 11.078”, E 138° 30’ 34.062”, 165 Maurice: S 32° 51’ 13.000”, E 138° 30’ 34.000”, Clarke 1858, Sydney: S 32° 51’ 11.482”, E 138° 30’ 42.29”, and Astronomic: S 32° 51’ 11.341”, E 138° 30’ 25.110”. The Central origin was therefore retained, but is now defined in terms of the Johnston memorial cairn. The Central origin was originally defined in terms of the trigonometrical station Grundy, whose coordinates on both the 165, Central datum and the Australian National Spheroid, Central origin were: S 25° 54’ 11.078”, E 138° 30’ 34.062”, 165 Maurice: S 32° 51’ 13.000”, E 138° 30’ 34.000”, Clarke 1858, Sydney: S 32° 51’ 11.482”, E 138° 30’ 42.29”, and Astronomic: S 32° 51’ 11.341”, E 138° 30’ 25.110”.

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detic 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: \( \Delta X = -119.353 \text{ m}, \Delta Y = -48.301 \text{ m}, \Delta Z = +139.484 \text{ m}, R_x = -7.243 \times 10^{-3} \text{ radians}, R_y = -4.538 \times 10^{-3} \text{ radians}, R_z = -7.627 \times 10^{-3} \text{ radians}, \) and \( \Delta s = -6.13 \times 10^{-1} \).

From Australian Geodetic Datum 1984 to WGS84: \( \Delta X = -117.763 \text{ m}, \Delta Y = -51.51 \text{ m}, \Delta Z = +139.061 \text{ m}, R_x = -5.096 \times 10^{-3} \text{ radians}, R_y = -7.732 \times 10^{-3} \text{ radians}, R_z = -4.835 \times 10^{-3} \text{ radians}, \) and \( \Delta s = -1.91 \times 10^{-1} \).

Australia is a free and open society. Their geodesy is not a secret and their history, their coordinates, and their datum transformations are an open book — a very large open book, but definitely open. Thanks go to Malcolm A. B. Jones, "Geodesy Jones," of Perth for the enormous accumulation of Australian historical geodetic documents he has sent to me over the years.

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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).