



THE PEOPLE'S REPUBLIC OF CHINA

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 Louisiana State University.

The Chinese civilization spread originally from the Yellow River valley where it probably existed beginning from around 3000 B.C. The first valid historical evidence is of the Chou Dynasty (1122-255 B.C.). For most of its 3,500 years of history, China led the world in agriculture, crafts, and science. It fell behind in the 19th century when the Industrial Revolution gave the West superiority in military and economic affairs. China is composed of mostly mountains, high plateaus, and deserts in the west; plains, deltas, and hills in the east. The lowest point is Turpan Pendi at 154 m (505 ft); the highest is Mount Everest at 8,848 m (29,029 ft).

China has 23 provinces, 5 autonomous regions, and 4 municipalities for its administrative divisions. Note that China considers Taiwan as its 23rd province, and it has recently acquired two other special administrative regions: the British Colony of Hong Kong (*PE&RS*, January 1998), and the Portuguese Colony of Macau.

The father of scientific cartography was Pei Hsiu (224-271 A.D.). In 1707-1717, Emperor K'anghsi commissioned a group of Jesuits to carry out a survey of the Chinese Empire. In 1902, the Manchu government established the Military Survey Institute and a 1:1,000,000 map series was planned. By 1911, the revolution changed the political horizons, and no noticeable progress was made until 1927 when the first modern series of geodetic surveys

were performed by the military until the Sino-Japanese war of 1937-1945. In 1928, the Central Bureau of Land Survey (CBLS) under the Army General Staff was formed. First-Order triangulation began in 1929 in Chekiang Province. In 1930, the CBLS organized the first training class in photogrammetry in Nanking. In 1931, large-scale triangulation projects were also started in Anhwei, Hunan, Hupeh, Kiangsi, and Kiangsu provinces. That same year CBLS started flying aerial photography with one airplane, and by 1935 it was using seven airplanes with cameras using 135 mm and 210 mm focal length lenses.

The Japanese established the Manchurian Principal System (Datum) of 1933 at the origin point, Huan-his-ling (Shinkyō) where: $\Phi_0 = 43^\circ 49' 36.62''$ North, $\Lambda_0 = 125^\circ 18' 15.42''$ East of Greenwich, and the defining azimuth to station Ta-hei-shan is $\alpha_0 = 204^\circ 46' 54.497''$. Of course, according to Japanese tradition established with the Tokyo Datums of 1892 and 1918, the Bessel ellipsoid of 1841 was referenced where the semi-major axis (a) = 6,377,397.155 meters and the reciprocal of flattening ($1/f$) = 299.1528128. (See Grids and Datums on Korea in the November 1999 *PE&RS*.) Back in June of 1980, Frank Kuwamura of the Defense Mapping Agency wrote to me and offered that, "If we denote the Tokyo Datum of 1918 with a "T" subscript, and the Manchurian System of 1933 with a "M" subscript, then $\phi_T = \phi_M + \phi'$ and $\lambda_T = \lambda_M + \lambda'$, where $\phi' = -8.8386'' + 0.00430 \Delta\phi \cdot 10^{-4} - 0.43463 \Delta\lambda \cdot 10^{-4} + 0.00001 \Delta\phi^2 \cdot 10^{-8} + 0.00021 \Delta\phi\Delta\lambda \cdot 10^{-8} + 0.01041 \Delta\lambda^2 \cdot 10^{-8} + 0.0017 \Delta\lambda^3 \cdot 10^{-12}$, and $\lambda' = 17.8824'' + 0.82927 \Delta\phi \cdot 10^{-4}$

$- 0.40987 \Delta\lambda \cdot 10^{-4} + 0.03866 \Delta\phi^2 \cdot 10^{-8} - 0.03971 \Delta\phi\Delta\lambda \cdot 10^{-8} - 0.01008 \Delta\lambda^2 \cdot 10^{-8} + 0.002454 \Delta\phi^3 \cdot 10^{-12} - 0.00186 \Delta\phi^2\Delta\lambda \cdot 10^{-12} - 0.000978 \Delta\phi\Delta\lambda^2 \cdot 10^{-12} + 0.0016 \Delta\lambda^3 \cdot 10^{-12}$. Furthermore, $\Delta\phi = \phi_M - \phi_0$ and $\Delta\lambda = \lambda_M - \lambda_0$ where the units are in arc seconds and ϕ_0 and λ_0 represent the coordinates of the Manchurian System of 1933 origin point (listed above)."

The CBLS established the Nanking Datum of 1935 where: $\Phi_0 = 32^\circ 04' 19.7445''$ North, $\Lambda_0 = 118^\circ 50' 18.5354''$ East of Greenwich. A Gauss-Krüger Transverse Mercator Grid is defined at the Datum origin. The scale factor at origin ($m_0 = 1.0$); the False Easting and the False Northing = zero. The ellipsoid of reference is the International (also called the Hayford 1909 and the Madrid 1924) where the semi-major axis (a) = 6,378,388 meters, and $1/f = 297$.

In addition to the CBLS surveys and maps, there were myriad local surveying and mapping activities pursued throughout the 20th century in the People's Republic of China. For instance, the Chihli River Commission used a Grid for 1:50,000 maps where the Central Meridian is $116^\circ 25' 24''$ East of Greenwich, the Central Parallel is $37^\circ 20'$, the False Easting and False Northing = zero. What projection? Probably a Lambert Conformal Conic because of a paper published by J. T. Fang of the National Geological Survey of China. In 1949, J. T. Fang published a series of papers in *Empire Survey Review* concerning the Lambert Conformal Projection as applied to China. "It has been decided by the Central Land Survey of China to adopt the Lambert conformal projec-

CONTINUED ON PAGE 563

CLIFFORD J. MUGNIER, C.P., C.M.S.

Grids & Datums

CONTINUED FROM PAGE 561

tion as the basis for the co-ordinate system, and, in order to meet the requirements of geodetic work, the whole country is subdivided into eleven zones bounded by parallels including a spacing of $3\frac{1}{2}$ degrees in latitude-difference. To each of these zones is applied a Lambert projection, properly chosen so as to fit it best. The two standard parallels of the projection are situated at one-seventh of the latitude-difference of the zone from the top and bottom. Thus, the spacing between the standard parallels is $2\frac{1}{2}$ degrees. This gives a maximum value of the scale factor of less than one part in four thousand, thus reducing the distortions of any kind to a reasonable amount." Fang later went on to explicitly list some of the parameters of the "Fifth Zone" where, "The standard parallels of this zone are at latitudes $34^{\circ} 10' N$ and $36^{\circ} 40' N$. Thus, $\phi_0 = 35^{\circ} 25' 11.84746''$ as referenced to the International ellipsoid (also called the Hayford 1909 and the Madrid 1924) where $a = 6,378,388$ meters, $1/f = 297$." Example computations are given by Fang for Fourth and Fifth Zone transformations.

In the late 1970s, I had the bright idea of going into business as a consulting cartographer. I moved my family back home to New Orleans and started pursuing the "oil patch" clientele. Lo and behold, I received a telephone call from Houston about the South China Sea. The People's Republic of China tendered bids for the exploration and development of hydrocarbon resources (oil and gas) in the South China Sea, and was looking for companies to perform geophysical exploration of its outer continental shelf. A U.S.-owned company (identity to remain anonymous), "cooked up" a specification for a projection and Grid System for geophysical exploration in the

South China Sea. The ellipsoid (and presumably the Datum) was the World Geodetic System of 1972. However, the projection was chosen as the Lambert Conformal Conic with two standard parallels and a latitude of origin equal to the arithmetic mean of the standard parallels. That sort of thing will work on a sphere, but on an ellipsoid (WGS72), it is a mathematical impossibility!

I worked up the two different Grids based on the two exclusive presumptions: hold to the two standard parallels and let the latitude of origin "float," or hold to the latitude of origin and let the two standard parallels "float." I termed those two mathematical possibilities as "PRC South China Sea I" and "PRC South China Sea II." To this day, I get phone calls to the effect, "Hey Cliff, ever hear about PRC South China Sea _XX_?" It never ceases to amaze me that they actually find (and produce) oil out there

There are some traditional Grid Systems associated with China. "China Belts I and II" are Gauss-Krüger Transverse Mercator Grids referenced to the Clarke 1880 ellipsoid (ersatz WWII systems), where the Central Meridians are at 119° (Belt I) and 113° (Belt II). Scale factor at origin = 0.9994, the False Northing = -2,210,000 meters and the False Easting = 400 Km. These specifications are part of the "British Grids" and, although richly romantic in history, they are lacking in *provenance*.

Current Grid Systems attributed to the People's Republic of China find their roots in the Russian (USSR) origins of assistance. For instance, the Russia Belts for China are identical with the UTM specification with the exceptions or variations that the scale factor at origin is unity rather than 0.9996, and the

ellipsoid of reference is the Krassovsky 1940 where the semi-major axis (a) = 6,378,245 m, and $(1/f) = 298.3$. A variation on this is known as the three-degree Belts, and the location of the Central Meridians are simply a (half) scalar of the six degree belts

If you have questions or comments relating to the Grids and Datums columns or would like to request that a specific country be covered in a future column, please contact Cliff Mugnier at cjmce@LSU.edu.