

JAPAN

Japan was inhabited by humans as early as 30,000 B.C. Its written history began in the 5th century A.D., after it adopted handwriting from the Chinese culture. Buddhism was introduced *circa* 552, and Japan closely imitated Chinese institutions during the sixth to ninth centuries. First visited by the Portuguese in 1542-43, European influences had little effect on religion; Shintoists and Buddhists represent 84 percent of the current population and Christianity is practiced by less than one percent. For several hundred years, the Portuguese had far greater influence than the later English and Dutch trading companies. Commodore Mathew Perry, USN, secured the first commercial treaty in 1853. The "Land of the Rising Sun" is a constitutional monarchy with a parliamentary government. There are 47 prefectures. Japan's independence dates back to 660 B.C. (traditional founding by Emperor Jimmu), and its constitution is dated 03 May 1947.

Comprised of four main islands—Honshū, Shikoku, Kyūshū, and Hokkaidō—Japan also includes the Bonin Islands (Ogasawara-Guntō), Daitō-Shotō, Minami-Jima, Okino-tori-Shima, Ryukyu Islands (Nansei-Shotō), and Volcano Islands (Kazan-Rettō). Japan is mostly mountainous; the lowest point is Hachirō-Gata (lake) at -4 m, the highest is Fuji-Yama at 3,776 m, and both places are on the island of Honshū.

In 1869, the Survey Division of the Ministry of Civil Services was established. In 1888, the Imperial Land Survey of the Army General Staff absorbed the Survey Division and carried out the fundamental surveying and mapping of the entire Japanese Empire. The Tokyo Datum of 1892 was established at the Azabu origin where $\phi_o = 35^\circ 39' 17.5148''$ North and $\lambda_o = 139^\circ 44' 30.097''$ East of Greenwich. The defining azimuth was determined from the old Tokyo Observatory at Azabu to station Kanou-Yama (Kanou Mountain) as $\alpha_o = 156^\circ 25' 28.442''$. The Tokyo Datum of 1892 was referenced to the Bessel 1841 ellipsoid where the semi-major axis (a) = 6,377,397.155 meters and the reciprocal of flattening ($1/f$) = 299.1528128. The pervasive Tokyo Datum of 1918 reflected a new determi-

nation of longitude at Azabu Observatory such that the origin was re-defined as $\phi_o = 35^\circ 39' 17.5148''$ North and $\lambda_o = 139^\circ 44' 40.5020''$ East of Greenwich. The orientation was not changed, and the deflection of the vertical at the observatory was defined to be nil. The ellipsoid height of mean sea level in Tokyo Bay was defined to be -24.414 m. For military use, the Japanese Imperial Land Survey (JILS) used a conformal double transverse Mercator grid known as the Gauss-Schreiber Transverse Mercator grid from about 1892 to 1921. (That's the same formulae that the U.S. Coast & Geodetic Survey chose for the TM zones on the North American Datum of 1927.) The multiple belt system defined the East Belt origin as $\phi_o = 36^\circ 03' 34.9523''$ N and $\lambda_o = 139^\circ 44' 40.5020''$ E, where

der station (now called Hu-tzu-shan in Taiwan) was the X axis origin. These grids did not use false origins, and in all cases the scale factor at origin (m_o) was equal to unity. The purpose of the JILS Grids was to compute the basic primary triangulations of these areas. Similar systems were implemented by the JILS in Manchuria, China (*PE&RS*, May 2000), and Korea (*PE&RS*, November 1999).

According to John W. Hager, "After 1921, the JILS Grids changed to the following: Latitude of Origin for Korea and zones 1 through 5 is 36° N, for Formosa 24° N. The Longitudes of Origin - Korea 128° , zone 1 132° , zone 2 136° , zone 3 140° , zone 4 144° , zone 5 148° , and Formosa 121° . All zones use a unity Scale Factor, and False coordinates were used, but the only one I have is for zone 2 where

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the X axis began at the meridian crossing the transit circle at Tokyo Observatory. The East Belt covered the area south of the Tsugaru Kaikyō (Strait) and east of 135° , comprising all of Honshū east of Kōbe to 142° . The West Belt origin was $\phi_o = 36^\circ 03' 34.9523''$ N and $\lambda_o = 132^\circ 04' 42.9183''$ E, where the meridian crossing the Kammuri-Yama first-order station in Hiroshima-Ken was the X axis origin, and the limits of the West belt were from 126° to 135° . The North Belt origin was $\phi_o = 45^\circ 00' 00''$ N and $\lambda_o = 142^\circ 15' 17.2085''$ E, where the meridian crossing the Yubari-Dake first-order station in Hokkaidō was the X axis origin, and was used for computation in Hokkaidō. This North Belt was also used in Karafuto, the southern half of Sakhalin Island, invaded during the Russo-Japanese War of 1904-1905 and occupied by the Japanese until after WWII. The southern belt covered the area south of 31° where the Formosa Belt origin was $\phi_o = 23^\circ 40' 00''$ N and $\lambda_o = 120^\circ 58' 25.9750''$ E, where the meridian crossing the Koshizan first-or-

FN = 6,000 km, and FE = 3,600 km. Notes on the Japanese Artillery (JA) versus the JILS: where JILS X (northing) = 0 meters = JA Y = 250,000 meters, JILS Y (easting) = 0 meters = JA X = 200,000 meters. Further stated that Latitude of Origin = 28° N, Longitude of Origin = $129^\circ 19' 23.6028''$ E, (Yuan-Dake). This is marked as the New Tokyo (1918) value and with a further remark to see also $129^\circ 19' 13.1978''$ E, which is the Old Tokyo (1892). Convenient in that the grid values are the same and only the geographic vary. The Korean National Geography Institute and National Construction Research Institute use the same gimmick by increasing the longitude of origins by $10.405''$."

After WWII, the duties of the JILS were transferred to the Geographical Survey Institute (GSI) in the Ministry of Home Affairs. In 1947, a new Surveying Law defined 13 zones for cadastral mapping ("Public Survey"), on the Gauss-Schreiber Transverse Mercator Grid with specific prefectures for each zone. For

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Zone 1, $\phi_o = 33^\circ 00' N$ and $\lambda_o = 129^\circ 30' E$, required for Nagasaki and Saga. For Zone 2, $\phi_o = 33^\circ 00' N$ and $\lambda_o = 131^\circ 00' E$, required for Fukuoka, Ōita, Kumamoto, Miyazaki, and Kagoshima. For Zone 3, $\phi_o = 36^\circ 00' N$ and $\lambda_o = 132^\circ 10' E$, required for Yamaguchi, Shimane, and Hiroshima. For Zone 4, $\phi_o = 33^\circ 00' N$ and $\lambda_o = 133^\circ 30' E$, required for Kagawa, Ehime, Tokushima, and Kōchi. For Zone 5, $\phi_o = 36^\circ 00' N$ and $\lambda_o = 134^\circ 20' E$, required for Hyōgo, Tottore, and Okayama. For Zone 6, $\phi_o = 36^\circ 00' N$ and $\lambda_o = 136^\circ 00' E$, required for Fukui, Shiga, Mie, Nara, Wakayama, Kyōto, and Ōsaka. For Zone 7, $\phi_o = 36^\circ 00' N$ and $\lambda_o = 137^\circ 10' E$, required for Ishikawa, Toyama, Gifu, and Aichi. For Zone 8, $\phi_o = 36^\circ 00' N$ and $\lambda_o = 138^\circ 30' E$, required for Niigata, Nagano, Gumma, Yamanashi, and Shizuoka. For Zone 9, $\phi_o = 36^\circ 00' N$ and $\lambda_o = 139^\circ 50' E$, required for Fukushima, Tochigi, Ibaraki, Chiba, Saitama, Kanagawa, and Tōkyō. For Zone 10, $\phi_o = 40^\circ 00' N$ and $\lambda_o = 140^\circ 50' E$, required for Aomori, Akita, Yamagata, Iwate, and Miyagi. For Zone 11, $\phi_o = 45^\circ 00' N$ and $\lambda_o = 140^\circ 15' 19'' 17.2085'' E$, where the central meridian is 2° west of the Longitude of the Yubari-dake first-order trig. station in Hokkaidō. Zone 11 is required for the following sub-prefectures of Hokkaidō: Iburi, Usu, Abuta, Hiyama, Shiribeshi, Otaru, Hakodate, and Ōshima. For Zone 12, $\phi_o = 45^\circ 00' N$ and $\lambda_o = 142^\circ 15' 19'' 17.2085'' E$, where the central meridian is the longitude of the Yubari-dake first-order trig. station in Hokkaidō. Zone 12 is required for the following sub-prefectures of Hokkaidō: Sapporo, Ishikari, Abashiri (Mombetsu), Asahigawa, Kamikawa, Soya, Urakawa, Muroan, Yūbari (excluding Usu and Abuta), Sorachi, and Rumoi. For Zone 13, $\phi_o = 45^\circ 00' N$ and $\lambda_o = 144^\circ 15' 19'' 17.2085'' E$, where the central meridian is the longitude of the Yubari-dake first-order trig. station in Hokkaidō. Zone 13 is required for the following sub-prefectures of Hokkaidō: Nemuro, Kushiro, Abashiri (excluding Mombetsu), Kasai, and Kushiro. As usual, there was no false origin, and the scale factor at origin was equal to unity for all of these grids for the "Public Survey."

Thanks to Professor Kazuo Kobayashi of the Survey College of Kinki, there have been some new additions to the "Grids of the Public Survey." Hager later pored over some maps to identify the likely areas of coverage. For Zone 14, $\phi_o = 26^\circ 00' N$ and $\lambda_o = 142^\circ 00' E$, and appears to be for the Bonin Islands (Ogasawara-Guntō) and Volcano Islands (Kazan-Rettō). For Zone 15, $\phi_o = 26^\circ 00' N$ and $\lambda_o = 127^\circ 00' E$, and appears to be for Okinawa Guntō and Amami Guntō. For Zone 16, $\phi_o = 26^\circ 00' N$ and $\lambda_o = 124^\circ 00' E$, and appears to be for Sakishima Guntō. For Zone 17, $\phi_o = 26^\circ 00' N$ and $\lambda_o = 131^\circ 00' E$, and appears to be for the Daito Islands (Kita Daito Jima and Okino Daito Jima). For Zone 18, $\phi_o = 20^\circ 00' N$ and $\lambda_o = 136^\circ 00' E$, and appears to be for Parece Vela.). For Zone 19, $\phi_o = 26^\circ 00' N$ and $\lambda_o = 154^\circ 00' E$, and appears to be for Marcus (Minami Tori Shima).

In 1985, Toshiyuki Shiina, general manager of the Geodetic Surveying Department of the Aero Asahi Corporation wrote to me of the special grid he devised for the Seikan Tunnel Project. (The project was the longest tunnel under the seabed in the world at the time.) Because the tunnel spanned two Public coordinate grids between the Main Island of Honshū and the northern island of Hokkaidō, he chose to define his own special purpose grid for the project based on the Gauss-Krüger Transverse Mercator projection. Shiina also chose a scale factor at origin, $m_o = 0.9999$ and the projection origin at $\phi_o = 41^\circ 10' N$ and $\lambda_o = 140^\circ 10' E$.

The GSI reports that it is moving the country to the Japanese Geodetic Datum 2000 (JGD2000). The National Imagery and Mapping Agency (NIMA) reports in Technical Report 8350.2 (January, 2000) that the transformation (for Japan) from Tokyo 1918 to WGS84 is $\Delta a = 739.845$, $\Delta f \times 10^4 = 0.10037483$, $\Delta X = -148m \pm 8m$, $\Delta Y = -507m \pm 5m$, and $\Delta Z = -685m \pm 8m$.



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