Grids & Datums

Sakhalin Island

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

"Sakhalin was inhabited in the Neolithic Stone Age. Among the indigenous people of Sakhalin are the Ainu and the Nivkh, as well as others. The Chinese (*PE&RS*, May 2000) in the Ming dynasty knew the island as Kuyi, the Ming sent 400 troops to Sakhalin in 1616, after a newfound interest because of northern Japanese (*PE&RS*, February 2002) contacts with the area, but later withdrew as it was considered there was no threat to China from the island. A Japanese settlement in the southern end of Sakhalin of Ootomari was established in 1679 in a colonialization attempt. The 1686 Nerchinsk Treaty between Russia and China, which defined the Stanovoy Mountains as the border, made no explicit mention of the island. However, as the Chinese governments did not have a military presence on the island, people from both Japan and Russia attempted to colonize the island, albeit from different ends. Sakhalin became known to Europeans from the travels of Ivan Moskvitin and Martin Gerritz de Vries in the 17th century, and still better from those of Jean-François de La Pérouse (1787) and Ivan Krusenstern (1805). On the basis of it being an extension of Hokkaido, geographically and culturally, Japan unilaterally proclaimed sovereignty over the whole island in 1845, as well as the Kuril Islands, as there were competing claims from Russia. In 1855, Russia and Japan signed the Treaty of Shimoda, which declared that both nationals could inhabit the island: Russians in the north and Japanese in the south, without a clear boundary between. Following the Opium War, Russia forced the Qing to sign the unequal Treaty of Aigun and Convention of Peking, under which China lost claim to all territories north of Heilongjiang (Amur) and east of Ussuri, including Sakhalin, to Russia. A *katorga* (penal colony) was established by Russia on Sakhalin in 1857, but the southern part of the island was held by the Japanese until the 1875 Treaty of Saint Petersburg, when they ceded it to Russia in exchange for the Kuril Islands."

In the first days of 1904, the famous American novelist, Jack London heard of Japan mobilizing for war against Russia. Obtaining employment from Hearst newspapers, London sailed for Yokohama with a contingent of other reporters on January 7th. After many columns had been posted and printed along with the first photographs of the conflict ever published in the United States by the Hurst newspapers, London was exiled from his attachment with the Japanese Army. His Courts Martial death sentence (fist fight on the battle front with a man that was stealing the feed of London's horse), was pardoned by the Imperial Japanese Army through the personal intercession of President Teddy Roosevelt. President Roosevelt later served as mediator at the subsequent peace conference, which was held at Portsmouth, New Hampshire, (August 9 - September 5, 1905). In the resulting Treaty of Portsmouth, Japan gained control of the Liaotung Peninsula (and Port Arthur) and the South Manchurian railroad (which led to Port Arthur), plus half of Sakhalin Island below 50° N reverted to Japan. "South Sakhalin was administrated by Japan as Karafuto-chō, with the capital Toyohara, today's Yuzhno-Sakhalinsk, and had quite a large number of migrants from Japan and Korea. Karafuto plays a major part in the history of the development of the coordinate system of Sakhalin Island.

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"In August 1945, (*40 years later – Ed.*), according to the Yalta Conference (*Franklin D. Roosevelt, Winston Churchill, and Joseph Stalin – Ed.*), agreement, the Soviet Union took over the control of Sakhalin. The Soviet attack on South Sakhalin started on 11 August 1945, as a part of Operation August Storm, four days before the Surrender of Japan, after the bombing of Hiroshima. (Japan had quite a presence here, and developed much infrastructure.) It was not until the 113th Rifle Brigade and the 365th Independent Naval Infantry Rifle Battalion from *Sovietskaya Gavan* landed on To˜ro˜, a seashore village of western Sakhalin on 16 August that the Soviets broke the Japanese defense line. The Soviets completed the conquest of Sakhalin on 25 August 1945 by occupying the capital, Toyohara (*Cambridge Encyclopedia, Vol. 65*)."

Sakhalin is separated from the mainland by the narrow and shallow Mamiya Strait or Strait of Tartary, which often freezes in winter in its narrower part, and from Hokkaido (Japan) by the Soya Strait or Strait of La Pérouse. Sakhalin is the largest island of Russia, being 948 km long, and 25 to 170 km wide, with an area of 78,000 km². Nearly two-thirds of Sakhalin is mountainous. The Western Sakhalin Mountains peak in Mount Ichara, (1481 m) while the highest peak of the Eastern Sakhalin Mountains is Mount Lopatin, (1609 m) is also the island's highest mountain. Susuanaisky and Tonino-Anivsky ranges traverse the island in the south, while the swampy Northern-Sakhalin plain occupies most of its north.

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"In order to cover the Pacific Coast, particularly the Gulf of Tatary and Tatar Strait with nautical charts, the Chief Hydrographic Administration formed under Major General Zhdanko, the Expedition to Pacific Ocean (*Ekspeditsiya Vostochnoga Okeana*), which in 1909-1914 in this area carried out astronomic and magnetic observations, triangulation and topographical survey of the Coast at 1:8,400, 1:16,800, 1:21,000, 1:42,000 and 1:84,000 scale (*sic*). In the period of six years 42 astro stations and 165 trig points were determined and 4400 km^2 (of) coastal area (*was*) covered by topographical survey. The triangulation on continental coast extends from Sakhalin Bay (φ = 53° 30') to Cape Syurkum (φ = 53° 04') and on the western coast of Sakhalin Island from Baikal Bay (φ = 53° 30') to Cape Tyk (φ = 51° 44'). This triangulation consisting of 54 stations and 111 intersected points, in respect to its shape and manner in which the observations were carried out, is rather an exploratory than regular type of net. The acute angles and the sides with the lengths from 1-50 and more kilometers forming a net in which merely 35 triangles are closed and (*a*) large majority of trig points determined by intersection and even by resection would entirely justify such a statement. The stations of the low western coast of Sakhalin largely are determined by resection (Pothenot, Hansen) by observing the trig points located on the dominating continental coast. The astronomic stations were marked with wooden posts having (*an*) inscription consisting of (*the*) capital letter A and of (*a*) number showing the year of establishment. The trig stations were marked with a bottle set 2 feet below the ground level as (*a*) subsurface marker (*see PE&RS, October 2006 – Finland – for my comments concerning "standard" Russian survey markers – Ed.*); the bottle was covered by 4 bricks tied with cement together. Above markers of stations, wooden quadripode and tripode signals (pyramids) were erected. The intersected points, which were not clearly visible permanent objects, were marked by wooden poles with target boards without permanent surface and subsurface marks. In the determination of astronomic positions, 10" Hildebrand universal instruments and 6 – 11 portable chronometers were used. Only station 179 was determined by a sextant. The latitudes were determined by (*the*) Pevtsov method, the longitudes by (*the*) Tsinger method and the azimuths by observation of Polaris or (*the*) Sun. In the observation of triangulation 10" Hildebrand and 10" little Kern universal instruments were used. The observations were carried out by (*the*) directional method of Struve at 3 – 8 positions of the horizontal circle. In the computing (*of*) the angular condition of the closed triangles (*it*) was satisfied by $-{}^1/_3(\varepsilon \pm \nu)$ and (*the*) geographic coordinates (*were*) computed by Gaussian formulae on (*the*) Clarke 1880 ellipsoid (*where: a = 6,378,249.145, and 1/f = 293.465*).

"The northern part of the coastal triangulation covering the continental coast north of De Kastri Bay and (*the*) northwestern coast of Sakhalin consisting of 125 trig points was carried out in 1909 – 1913. In 1909 the base line on the Langr Island (*Ostrov Baydukov – Ed.*) was measured by 4 meter wooden rods along the string (*plumb bob string lines – Ed.*) and with the length d = 4,965.1859 m $\pm {}^1/_{70,000}$ served for the derivation of scale of the northern part of the net. In the same year for the purpose of the orientation of (*the*) northern part of the net, the Eastern Terminal of the base line was astronomically determined as follows: 371 (898) Langr, East Base Point Φ_o = 53° 18' 59.12" ±0.9", Λ_o = 141° 27' 38.68" ±2.3" East of Greenwich, with the astronomic azimuth determined in (*the*) Western Terminal to (*the*) Eastern Terminal $\alpha_{902WBP\text{-}898EBP}$ = 134° 35' 48.7" ±4.7". The position of (*the*) Eastern Terminal and the azimuth of the base line in the Western Terminal defined on (*the*) Clarke 1880 ellipsoid constitute the Langr Datum (*of 1909*).

"Independently of the northern part of the net, in 1910 in the De Kastri Bay (*Zaliv Chikhachëva – Ed.*), a small triangulation consisting of 9 trig points was established. In order to provide the scale for this triangulation, a base line with wooden rods along the string was measured. The length and accuracy of the base line are as follows: d = 693.2565 m $\pm {}^1/_{18,152}$. As the initial point in the computing of geographic coordinates, the astronomic station 235 De Kastri Bay, Eastern Observatory, determined in 1868 by Staritskiy and Onatsevich, was used with the following position: Φ_o = 51° 27' 50.7", Λ_o = 140° 48' 41.4" East of Greenwich. For the orientation of the net served the azimuth from the astronomic station 235 to 608 Southern Terminal of the base line determined in 1910 by observation of (*the*) Sun having the following value: α = 257° 24' 56.47" ±2.5". (*I do not believe a Solar Azimuth accuracy of ±2.5" was likely observed in 1910; more likely ±25.0" – Ed.*). The position of astronomic station 235 De Kastri Bay and the azimuth to 608 Southern Terminal defined on (*the*) Clarke 1880 ellipsoid constitute (*the*) De Kastri Datum (*of 1910*).

"In 1912, stations 599 Arbat Mountain and 613 De Kastri Mountain were observed and included into (*the*) 1910 triangulation. In 1913, the northern triangulation referring to Langr datum was extended from the side 682 Lazarev – 684 Pogobi to De Kastri Bay and stations 613 De Kastri Mountain , 600 De Kastri, Kloster Kamp, 599 Arbat Mountain and 596 Cape Soborniy of the local 1910 – 1912 net were observed and included into (*the*) Langr system. The side 600 – 613 common to Langr and De Kastri system differs for ${}^{\Delta S}/_S = {}^1/_{2,500}$. In 1914, (*the*) De Kastri triangulation was extended from the side 5 De Kastri Mountain, South Signal – 8 Kloster Kamp, Lighthouse (these two stations are not included in (*the*) Far East Catalogue) to the side 520 Topazovaya Mountain – 503 Lysaya (Syurkum) Mountain. In the computing of the net consisting of 31 stations the starting values used were those of 1910, hence the 1914 net together with De Kastri 1910 – 1912 triangulation constitutes a homogenous system of 40 trig points. Using the coordinates of the mentioned four stations (594, 599, 600, and 613), which were in 1913 included into (*the*) Langr system, the De Kastri system can be incorporated into (*the*) Langr system" (*Andrew W. Glusic, AMS Technical Report No. 31, Analysis of Surveys in the Russian Far East, 1960*).

A little over ten years ago, I was contacted by Marathon Upstream Sakhalin Services, Ltd. regarding a little problem that they had with Sakhalin Island coordinates. It seems that the company was founded jointly with the Russian government in order to design, construct, and build a pipeline from the offshore petroleum platforms east of Sakhalin to the island and then south to the port of Korsakov which is below the winter "ice line" of the northern Pacific Ocean. Marathon had initially informed the Russians that a large-scale topographic survey was necessary in order to plan the routing of the pipeline and that Marathon needed their permission to perform such a survey and mapping project. The Russians responded that such a mapping project was unnecessary, 1:10,000 scale topographic maps already existed, and that they would provide them to Marathon. Well, the Russians kept their word. They shipped complete topographic coverage of the southern half of the island (south of 50° N), at 1:10,000 scale map sheets as printed on 11"×17" paper. There was just one problem … there was a kilometer grid overprinted on each sheet, but there were little rectangular holes in each paper map sheet that had been physically cut in all four margins with a razor blade where the coordinates had presumably been printed! The values of whatever coordinate system existed were literally cut out, and no information was offered regarding the kilometer grid system of Sakhalin Island and its relation to any datum of latitude and longitude! Thanks to the KGB, but likely its successor (the

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FSB Федеральная служба безопасности), that was a secret. About that time, I received a telephone call from Marathon Oil in Houston, Texas.

I dropped by the office shortly thereafter and was greeted by Roger Holeywell, the Chief Cartographer of Marathon Oil Company. I was briefed on their conundrum and shown the maps in question. I noticed that in addition to the screwy-looking 11"×17" paper maps with little rectangular holes cut on all four margins, the contour maps had spot heights shown at hills and mountain tops with little dots and elevations shown. To me, some of those dots obviously were triangulation stations from past surveys; not all were photogrammetric spot heights. Being vaguely familiar with the history of the ping-pong possession of the island between the Imperial Russians and the Imperial Japanese, I thought that perhaps those spot height dots might offer an introduction to a geodetic Rosetta Stone of the island's coordinate system. Marathon had already contracted with a company to digitize the Sakhalin topographic maps, along with the dots and their elevation values. I was authorized to contact the company and they later delivered digital files of the spot heights in an arbitrary Cartesian coordinate system with the elevations listed as each spot height's identification.

Being familiar with the Russian penchant for obfuscation for the sake of obfuscation, I expected that the "secret" FSB coordinate system was a conformal one, and was probably based on a Gauss-Krüger Transverse Mercator projection. Question was, what were the coordinates of the origin? Holeywell already realized that the standard 1935 Russia Belts Transverse Mercator Grids did not match the major "rack" of the angle of the local grid system to the true meridian, and that was why I was called in for a consult. What was the "shift" of the coordinate system, what was the datum, and where was the origin located? Was there any relation to any "unclassified" coordinate system that Marathon Surveyors could use with their dual-frequency GPS receivers? (The Russians are notorious about not allowing foreign Geodetic Surveyors to collocate at ANY Russian triangulation stations!) Local coordinate systems are OK, but absolute ties are absolutely verboten!

The Marathon cartographic scanning contractors provided the local X-Y coordinates of the "spot heights" with the elevations listed as the IDs in an ASCII text list. My research partner at the time, Dr. Michael E. Pittman (now retired from the University of New Orleans), took the text list and matched the IDs of some of the spot heights with a Karafuto Trig List that had corresponding identical spot heights. Karafuto Trig List control - what was that? Well, after WWII, Japan lost the war in the Pacific. The meeting in Yalta referenced in a paragraph above (Roosevelt, Churchill, and Stalin), resulted in the Japanese Geodetic Control being part of the "spoils of war" acquired by U.S. Forces, and the southern half of Sakhalin Island was returned to Soviet possession – as well as the creation of the "Iron Curtain." Also, *Geodetic Surveying in Japan during 1927-1929* by Rikuti Sokuryobu was previously published in the IUGG 1930 Proceedings in Japan and it detailed the progress of Japanese Geodetic Triangulation in Karafuto actually since 1905 – remember the Portsmouth Treaty? The Karafuto Trig List geodetic coordinates as transformed to the Japanese Transverse Mercator Grid (North Belt) were compared with the Marathon contractor's ASCII list of spot heights and twenty points were found to match. Those twenty points were indeed triangulation stations and were not just photogrammetric spot heights. The 4 – parameter transformation equations derived were: $X = 1.0002x - 0.0007y + 3861.32$, $Y = 0.0007x + 1.0002y - 2242.79$. The angle of the X-Y local grid system on the paper maps with respect to true north indicated that the central meridian was at some significant longitudinal distance from the central axis of Sakhalin Island. On close examination, the convergence angle between grid north and true north was suspiciously close to the value of the origin of the Langr Datum of 1909 – over on the mainland. When the actual origin longitude was used for a central meridian, the system matched all Karafuto control to the digitized spot heights from the Russian 11"×17" paper maps.

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 (C^4G).