Surveying

Establishing position references

The position of the center of the VLBI antenna is measured in order to establish accurate position references (Ishioka VLBI observing facility in Ishioka City, Ibaraki Prefecture)

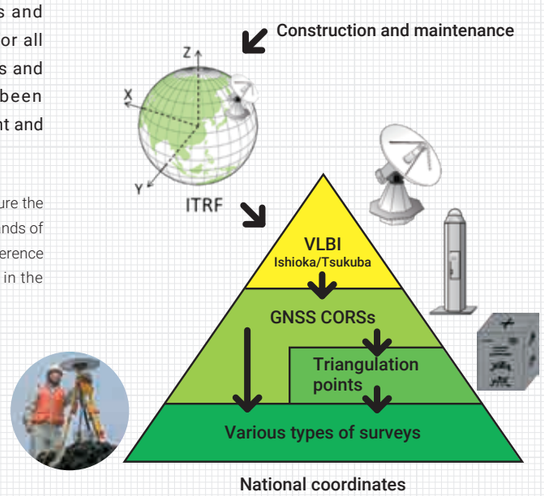
Establishing references for accurately surveying positions

The earth's shapes, latitudes and longitudes have been defined in accordance with the International Terrestrial Reference Frame (ITRF) which is constructed and maintained through global geodetic observations and international cooperation and coordination.

GSI uses VLBI*1 observations to determine the positions of Japan based on international standards. These positions are then used as a basis for establishing GNSS*2 CORSs and triangulation points which become reference points for all locations in Japan. These are used as reference points and universal rules (national coordinates) that have been standardized by Japan for the identification, management and security of its territory.

VLBI　SLR　GNSS　DORIS

Geodetic observations on a global scale



*1 VLBI(Very Long Baseline Interferometry): A technique to measure the distance between two or more parabolic antennas over thousands of km with a-few-mm accuracy, by calculating the arrival time difference of received signals radiated from celestial bodies far away in the universe.

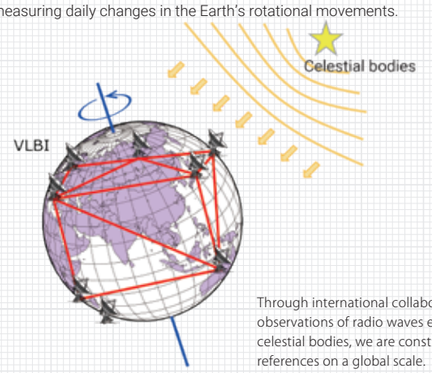
*2 GNSS(Global Navigation Satellite System): A collective term for satellite navigation systems that determine the position on the globe by using satellites, including the U.S. Global Positioning System (GPS), the Japanese Quasi-Zenith Satellite System (QZSS; known as "MICHIBIKI"), the Russian Global Navigation Satellite System (GLONASS), and EU's Galileo.

GGOS (Global Geodetic Observing System)

GGOS is an initiative for international collaboration for prompting the geodetic observations (VLBI, GNSS, SLR, DORIS and gravimetry) and integrating them in a global scale. GGOS is contributing to enhancing collaboration for realizing and sustaining the ITRF. GSI has taken over the presidency of GGOS, actively leading the lines.

VLBI surveying

GSI joins the international VLBI observations coordinated by the International VLBI Service for Geodesy and Astrometry (IVS), in cooperation with VLBI stations around the world. Through these observations, we are not only determining the positions accurately but also contributing to the maintenance of precision timekeeping through, for example, the insertion of "leap seconds", by precisely measuring daily changes in the Earth's rotational movements.



Through international collaborative observations of radio waves emitted by celestial bodies, we are constructing position references on a global scale.

GNSS CORS

The GNSS Continuously Operating Reference Station (GNSS CORS) is an observation facility that receives signals from GNSS satellites, such as GPS and QZSS satellites. About 1,300 GNSS CORSs are operating in throughout Japan.

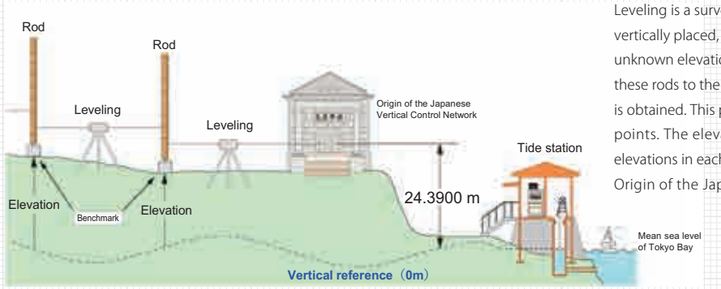
Received data are sent to the Operation Center at GSI in real-time to calculate precise positions of these stations. The GNSS CORS network is an important infrastructure widely used for precise positioning in ICT construction and smart agriculture as well as land surveying and crustal deformation monitoring in Japan.

In addition, water vapor data obtained from GNSS CORSs are also used in weather forecasting by the Japan Meteorological Agency.

GNSS CORS

Operation Center
(Tsukuba, Ibaraki)

Leveling



Standard method of leveling

Leveling is a surveying technique for determining elevations. Two leveling rods are vertically placed, one at a point of known elevation and the other one at a point of unknown elevation somewhere. By adding the difference in scale reading between these rods to the elevation of the known point, the elevation of the unknown point is obtained. This process is successively applied to determine elevations at arbitrary points. The elevations of benchmarks, used as references for determining the elevations in each area of Japan, are determined through leveling starting from the Origin of the Japanese Vertical Control Network, whose elevation is defined in reference to the mean sea surface (elevation 0 m) of Tokyo Bay.

Repeated leveling allows us to know the accurate temporal changes in elevations, and its results are also used as basic data for disaster mitigation.

Maintaining of control points on remote islands

Japan has many remote islands. GSI has constructed control points (triangulation points) on such islands and determined their latitudes, longitudes and elevations to identify and secure Japan's territories.

Construction of a 2nd order triangulation point (Hirase Island, Kagoshima Pref.)

Gravity surveys

GSI conducts gravity surveys at nationwide gravity points and publicizes the results which are adapted to the international standards. Values of gravity are required for determining accurate elevations and are widely used for exploration of underground active faults and resources and calibration of measuring instruments.

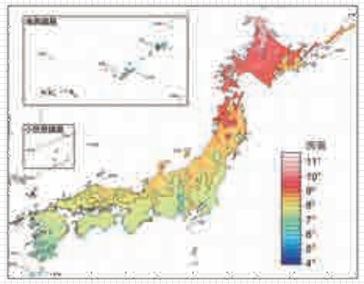
(Left) AQG Absolute quantum gravimeter
(Right) FG5 Absolute gravimeter

Geomagnetic surveys

It is known that the geomagnetic bearing and scale depend on the location and vary with time. GSI conducts geomagnetic surveys to identify the geographic distribution and chronological variation of geomagnetic fields.

In February 2022, the surveying results that had been obtained up to that time were compiled and publicly released as the "Values for the 2020.0 Magnetic Chart." This updated the declination of the entire country to the latest values, and, using compasses for mountain climbing, etc., we can gain more accurate knowledge of compass directions. The latest magnetic charts and declination values can be checked in GSI's website maps, "GSI Maps."

* Declination: deviation of the indicated north on a compass (magnetic north) from the geographic north (true north).



Distribution of declination values in the 2020.0 Magnetic Chart