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Comparison of the Baseline Length Between the Keystone Sites by Different Space Geodetic Techniques

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Abstract

Three independent space geodetic systems, VLBI, SLR and GPS, are closely located at the Keystone sites maintained by the Communications Research Laboratory (CRL). The main purpose of the system is the study of the crustal deformation around Tokyo area. The other purpose is to contribute to improve the terrestrial reference frame. In the summer of 2000, extraordinary crustal deformation was observed in the Keystone network due to the seismic and volcanic event occurred at the Izu islands about 150 km south of Tokyo. Full process of the event was observed by the VLBI system. And a part of the process was also observed by the SLR and GPS of CRL. This kind of significant crustal deformation was firstly observed by the collocated space geodetic systems. Exploiting unique facilities, baseline length is compared between the different space geodetic systems which are tied by the precise surveying. The obtained geodetic results are contributed to the IERS to improve the ITRF.

1. Key Stone Project

The Keystone Project (KSP) was planned to observe the crustal deformation around Tokyo area using VLBI, SLR and GPS. For this purpose, precise geodetic observation systems are deployed at four sites (Koganei, Kashima, Miura and Tateyama) for regular observation. Since 1996, regular VLBI observation has been carried out with four stations. Since 1997, we performed quasi real-time VLBI observation for quick service. The other aspect of the project is to study the advanced geodetic observation by the collocation of independent geodetic observation system. We can study the error sources which are invisible by the single system observation. Moreover, we can contribute to the terrestrial reference frame by the collocated system.

2. Local Tie at the Key Stone Network

Three independent space geodetic systems, VLBI, SLR and GPS, are closely located at the Keystone sites as is seen in Figure 2. Precise survey was repeatedly performed to have precise eccentricity vectors between the observing systems. It is essential to show how the surveying data is obtained instead of showing only the results because we discuss the millimeter precision. Sharing the information of how to measure the precise position of reference point must be beneficial. Hence, the surveying data and method is opened. It is available from the following URL (http://www2.crl.go.jp/t/team6/survey/contents.htm).

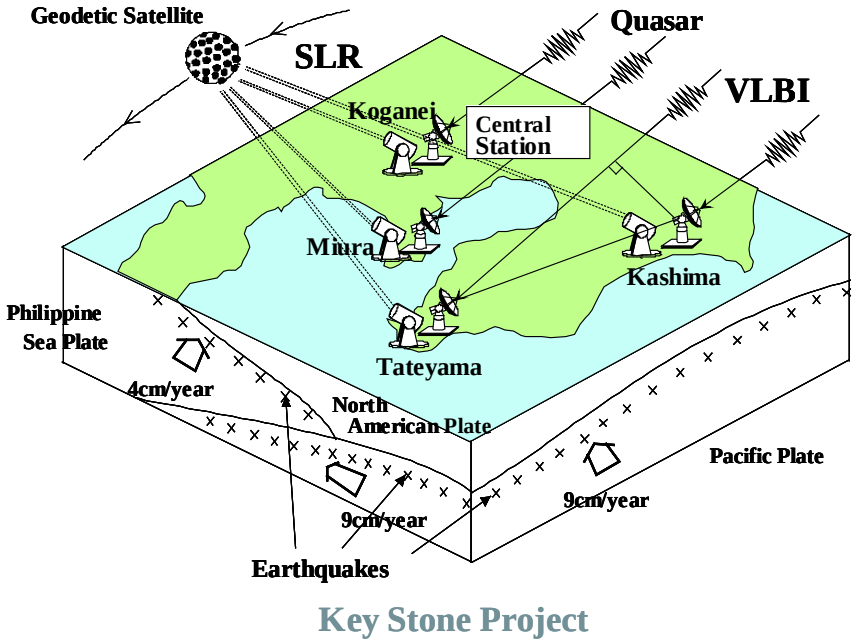

Figure 1. **Network of the keystone project.**

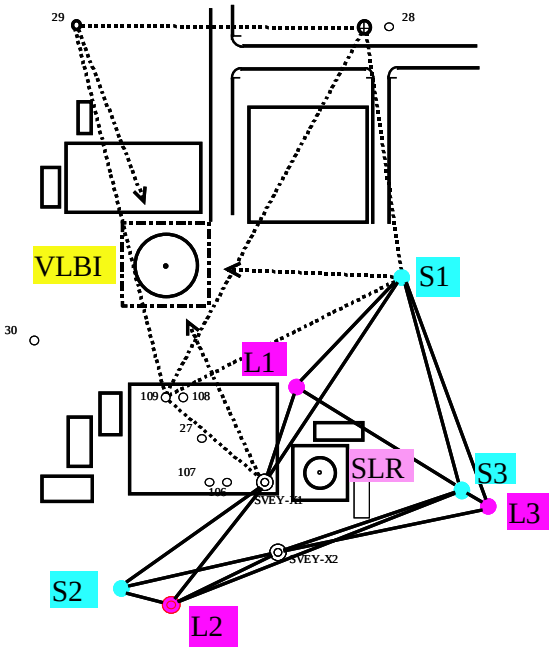

Figure 2. **Koganei site and the surveying network**

3. Extraordinary Crustal Deformation Observed in the Key Stone Network and the Comparison of the results from independent techniques

Extraordinary crustal deformation due to the seismic and volcanic activities at Izu islands was detected since the end of June, 2000 (Figure 3). The baseline length change over 2cm/month was

observed between Kashima and Tateyama, which is the largest in the Keystone network. It is one of the most significant crustal deformation detected by a space geodetic network of collocation sites. Full process of the event was observed by the VLBI system. And a part of the process was also observed by the SLR and GPS operated by CRL. Comparison of VLBI and SLR results is shown in Figure 4. Local tie data is applied to the plot. This is the first case to track the crustal deformation by both VLBI and GPS. Time resolution of SLR data is 15 days here. We see no bias between them within a formal error.

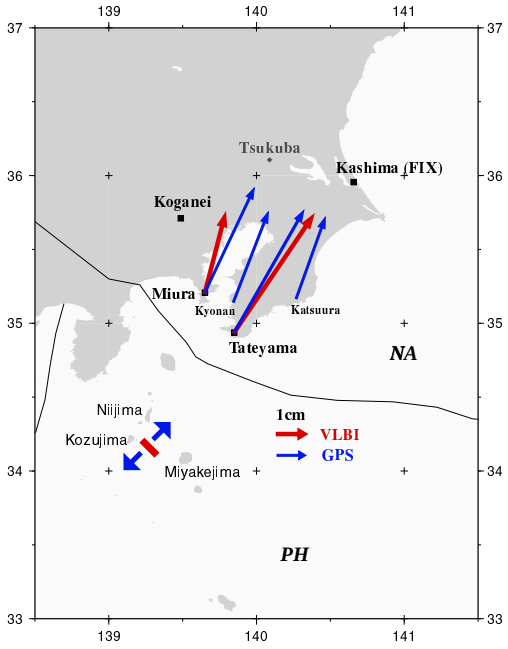

Figure 3. **Site displacement in June 26 - Sept. 15, 2000.(GPS: GEONET).**

4. VLBI and GPS observation

At the event of the summer in 2000, significant crustal deformation was observed firstly by both VLBI and GPS. Full process of the event was observed. Baseline length change of Kashima-Tateyama is shown in Figure 5. Systematic error is not found.

5. Contribution to the TRF

The obtained geodetic results and local tie data are contributed to the IERS to improve the ITRF. The data is to be included in the establishment of next ITRF.

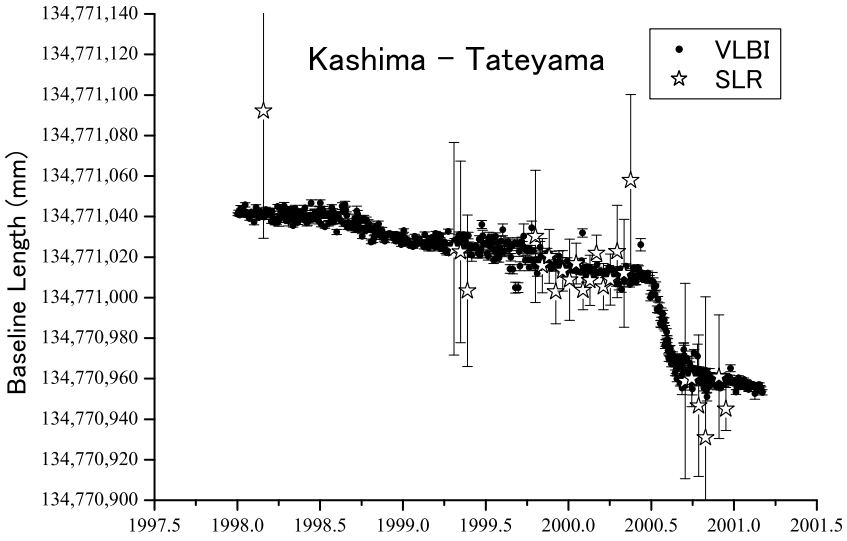

Figure 4. **Comparison of the baseline length observed by VLBI and SLR using the local tie vector. (VLBI: 24hrs. solution, SLR: 15 days solution.).**

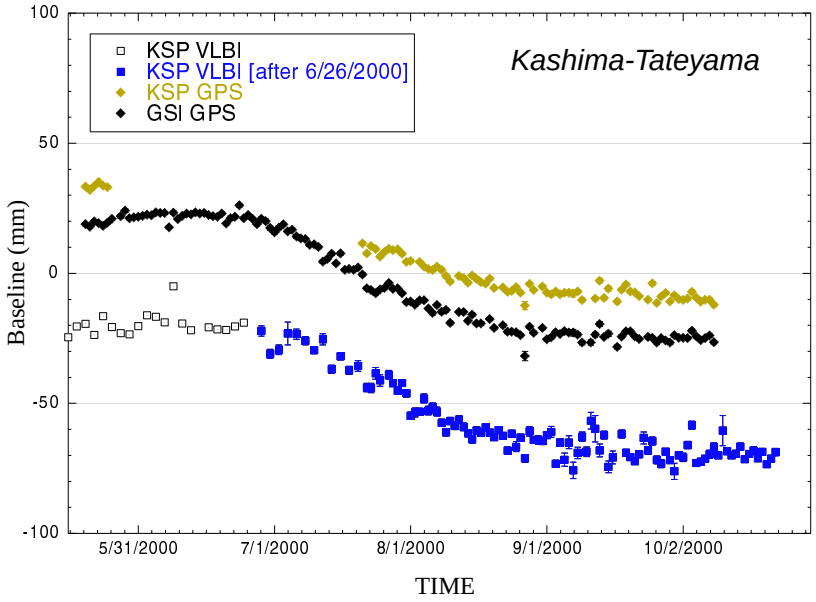

Figure 5. **Network of the keystone project.**