by LLNL, that became fully operational in April 1999. This system provides real-time kinematic surveying capability for precise (cm-level) mapping of archaeological sites and other features at Site 300, publicly available differential corrections for real-time meter-level navigation and positioning capability in the general vicinity of the site, and near real-time telemetry of the raw data stream for the fault monitoring activities at the BSL. The site was chosen for its good sky visibility, for its availability of rock outcrop for monument stability, and for its proximity to the Central Valley. Because it is located at one of the easternmost sites in the Diablo Range, it will provide valuable constraints on the total deformation accommodated between the Sierra Nevada range and the San Andreas fault system.

Installations are also currently being permitted and prepared at several other sites, including Barnabe Peak (BRNB), just east of the SAF in the north Bay Area, in the Modoc plateau (MODB) in the northeast corner of California, and two stations (COYB and SUNB) that will be collocated with USGS borehole strainmeters along the southern Hayward fault. The remaining two GPS receivers owned by the BSL will be used to support other surveying activities, such as measuring ties with existing benchmarks, or will reside in temporary installations to improve the spatial density of the network.

3. Site Upgrades

The BSL staff performed significant modifications to nearly all the other BSL stations. The firmware on every Ashtech receiver was upgraded to a version compatible with both 4-digit year numbers, in anticipation of the year 2000 (Y2K), and with the GPS Week Rollover. The GPS satellites keep time in weeks and seconds of week, beginning on Sunday, January 6, 1980. On August 22, 1999, the week number changed from 1023 to 0000 internally on the satellites due to memory bit limitations. The receiver firmware was modified to maintain continuity of week number after the rollover. None of the BSL receivers were adversely affected by this problem.

The BSL staff also installed antenna domes at many of the stations. We purchased SCIGN-designed hemispherical domes using federal (USGS) funding. Domes cover the antennas to provide security and protection from the weather and other natural phenomenon. Previously the BSL stations had a mixture of dome types or none at all, adding a potential non-uniformity to signal delays and antenna phase patterns. The new SCIGN dome is designed for the Dorne-Margolin antennas and minimizes differential radio propagation delays by being hemispherical about the phase center and uniform in thickness at the 0.1 mm level. It is also very resistant to damage and, in its long form in combination with the SCIGN-designed antenna adapter, can completely cover the dome and cable connections for added protection. Adding the dome does cause a slight degradation in the signal-to-noise ratio (SNR) of the radio signals. We compared the receiver SNR values at both L1 and L2 frequencies, and found this degradation to be minimal (Figure 5.2). Observations collected below 15 degrees are not typically used in GPS processing due to the higher scatter induced by signal multipath. Tall domes and adapters were installed at 5 stations that require the most security due to public accessibility: DIAB, MUSB, PTRB, SAOB, and YBHB. Short domes were installed at 7 less accessible stations: HOPB, LUTZ, MHCB, MONB, PKDB, POTB, and SODB.

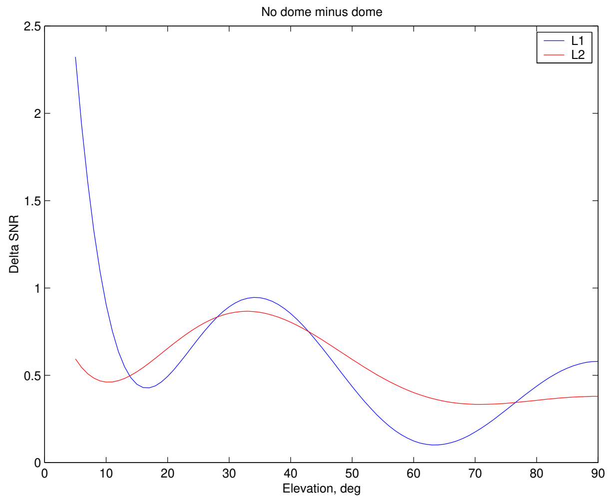

Figure 5.2: Signal-to-noise ratio (SNR) degradation caused by the SCIGN-designed antenna dome at L1 (blue) and L2 (red) frequencies versus satellite elevation above the horizon. SNR values for the Ashtech receivers are typically in the 150–200 range. Signals at all elevations are slightly degraded, with the greatest effect at low elevations in the L1 band. *Courtesy of M. Murray.*

Additional modifications were made to a number of the existing stations to make them consistent with the standard BSL station configuration. Low-voltage cutoff devices, described in previous reports, were installed at 6 stations: BRIB, MHCB, PKDB, SAOB, SUTB, and TIBB. Ashtech-to-Quanterra serial cables were installed at 6 stations in anticipation of a new telemetry method being developed by our staff (see below): FARB, HOPB, MHCB, PKDB, SAOB, and YBHB. Lightning protectors were installed on short-haul modem cables at CMBB and SAOB, which will be used for the Ashtech-to-Quanterra telemetry path. The BSL staff also helped to install a new low-latency telemetry path at the UCD1 station maintained by UC Davis. This station uses a Trimble receiver with a direct serial connection to a UNIX workstation. The new telemetry path allows automated ftp retrieval of the data in near-realtime, dramatically improving on the previous intermittent manual download method.

Significant station upgrades planned for the coming year include the conversion to choke-ring antennas at 2 remaining original stations (TIBB and BRIB), conversion to continuous telemetry of the 2 Trimble stations (MOLA and NUNE), and new monumentation at BRIB and CMBB to raise the antennas at least 0.5 meters above the ground to minimize multipath/troposphere modeling trade-offs that degrade the vertical position repeatability at these sites.

4. Continuous Telemetry

The BSL currently maintains and retrieves data from 18 Ashtech Z-12 receivers. Data from all stations are collected at 30-second intervals, transmitted continuously over serial connections, collected into 24-hour raw serial files and processed daily. The serial connections to 12 sites use frame relay technology, one site (TIBB) has a direct radio link to Berkeley and several sites (FARB, MUSB, PTRB, SODB, and SUTB) use a combination of radio and frame-relay technologies. We have developed software to interpret and collect the raw serial output into hourly files, which is then converted to the standard interchange RINEX format using the teqc software developed by UNAVCO.

Ten current GPS stations are collocated with broadband seismometers and Quanterra data collectors. With the support of IRIS we have developed software that will allow continuous GPS data to be stored on and retrieved from the Quanterra dataloggers (*Perin et al.,* 1998). This approach preserves GPS data during telemetry outages, and will be used at all the collocated stations after a new version of the Quanterra system software is installed this Fall. In anticipation, we have established and tested serial connections between the GPS receivers and dataloggers at six sites: FARB, HOPB, MHCB, PKDB, POTB, and YBHB.

5. Data Archival and Distribution

Raw and Rinex data files from the 18 BSL stations and the other stations run by BARD collaborators are archived at the BSL/USGS Northern California Earthquake Data Center (NCEDC) data archive maintained at the BSL (*Romanowicz et al.,* 1994). The data are checked to verify their integrity, quality, completeness, and conformance to the RINEX standard, and are then made accessible, usually within 2 hours of collection, to all BARD participants and other members of the GPS community through Internet, both by anonymous ftp and by the World Wide Web (http://quake.geo.berkeley.edu/bard).

Data and ancillary information about BARD stations are also made compatible with standards set by the International GPS Service (IGS), which administers the global tracking network used to estimate precise orbits and has been instrumental in coordinating the efforts of other regional tracking networks. The NCEDC also retrieves data from other GPS archives, such as at SIO, JPL, and NGS, in order to provide a complete archive of all high-precision continuous GPS measurements collected in northern California.

Many of the BARD sites are classified as CORS stations by the NGS, which are used as reference stations by the surveying community. All continuous stations operating in July 1998 were included in a statewide adjustment of WGS84 coordinates for this purpose. Members of the BARD project regularly discuss these and other common issues with the surveying community at meetings of the Northern California GPS Users Group.

In the past year the BARD Project and the NCEDC have collaborated with UNAVCO and other members of the GPS community to define database schema and file formats for the GPS Seamless Archive Centers (GSAC) project. When completed this project will allow a user to access the most current version of GPS data and metadata from distributed GSAC locations. The NCEDC will participate at several levels in the GSAC project: as a primary provider of data collected from BSL-maintained stations, as a wholesale collection point for other data collected in northern California, and as a retail provider for the global distribution of all data archived within the GSAC system. We have produced monumentation files describing the data sets that are produced by the BARD project or archived at the NCEDC, and are working to implement programs that create incremental files describing changes to the holdings of the NCEDC so that other members of the GSAC community can provide up-to-date information about our holdings.