

# Detecting Motion in the San Andreas Fault Zone

## Using static GPS

Geomatics Engineering  
**Students:** Corey C. Pippin  
**Advisors:** Dr. James K. Crossfield

### Abstract

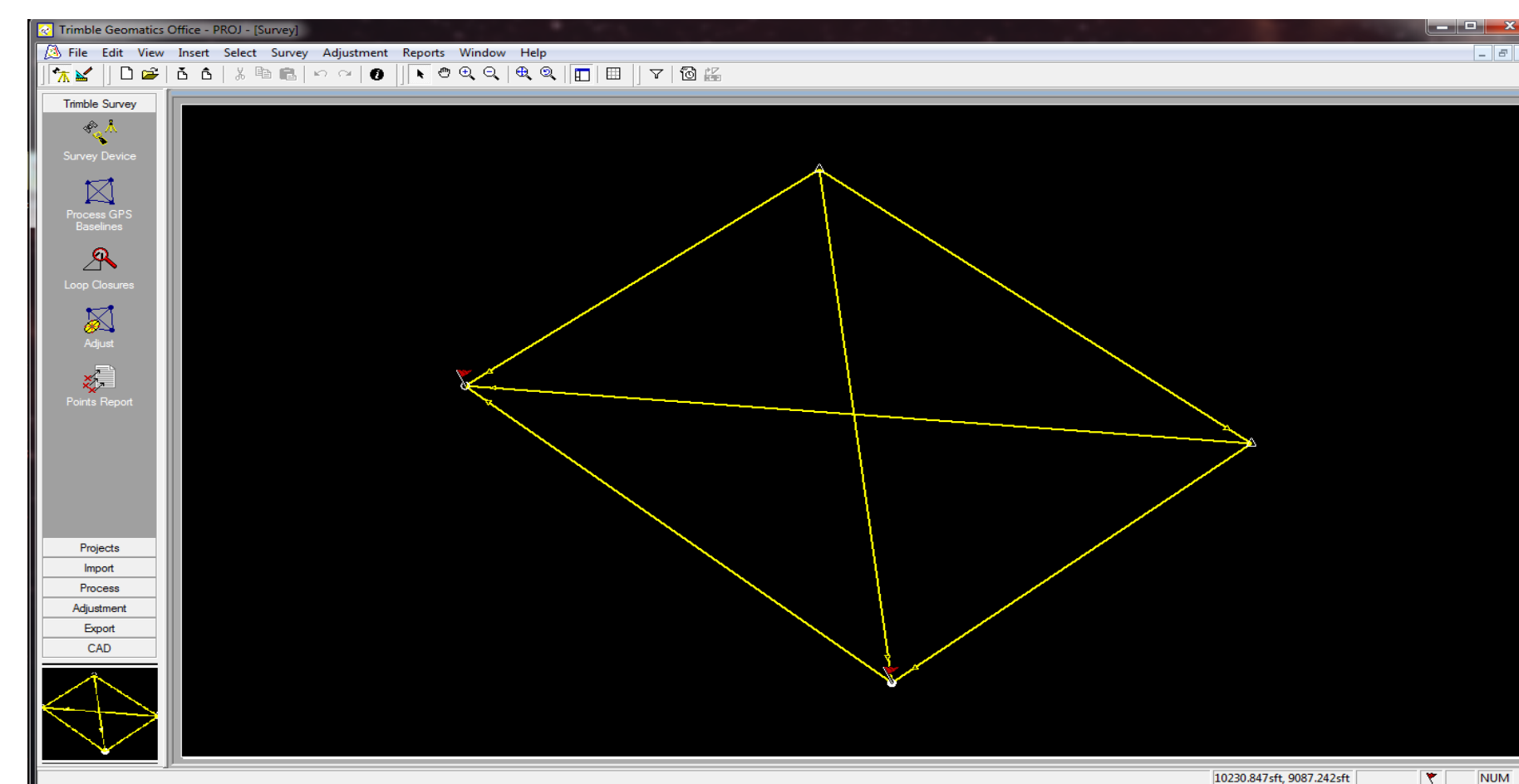
Static GPS observations were used to monitor crustal motion along the San Andreas Fault near Hollister, California. The points span both sides of the fault. Three 60 minute GPS observation sessions were conducted, and the relative positions of National Geodetic Survey monuments were precisely determined. Those coordinates were compared to known monument locations (adjusted to NAD83 in 1992) to quantify the relative motion of the fault zone. The distance and direction of the tectonic motion in this region was calculated. With the collected static data, processed using Trimble Geomatics Office software, the study region was observed to have movement of 1.223 feet (37.277 cm) (averaged) during the 22 years between observation periods. This equates to a movement of 0.0554 feet or 1.69 centimeters per year.

### Field Reconnaissance



On January 31<sup>st</sup>, 2014, with the assistance of Jacob Andresen, the 4 NGS monuments were located using the NGS data sheets for each point. They were then clearly marked to be visible upon return. Any overhead obstructions were noted to be included in the observation planning.

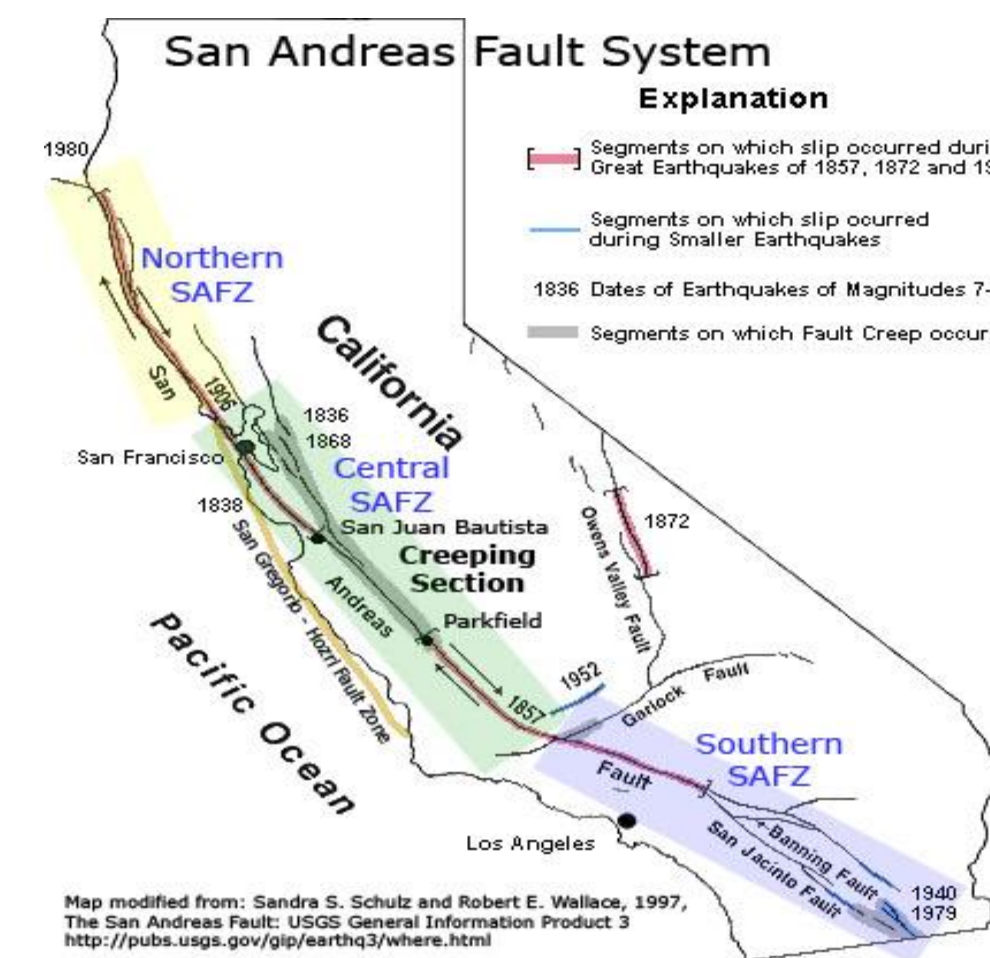
### Positional Computations



The files collected in the field were then imported into TGO. The baselines for similar observations were computed, resulting in the determined coordinates of each point in Latitude and Longitude. The coordinates for Taylor 6 & 7 were fixed. This was done to show the Pacific plate movement with respect to the North American plate in the fault zone. The coordinates were then adjusted with ephemeris data (corrected satellite positions) to increase accuracy of the point positions

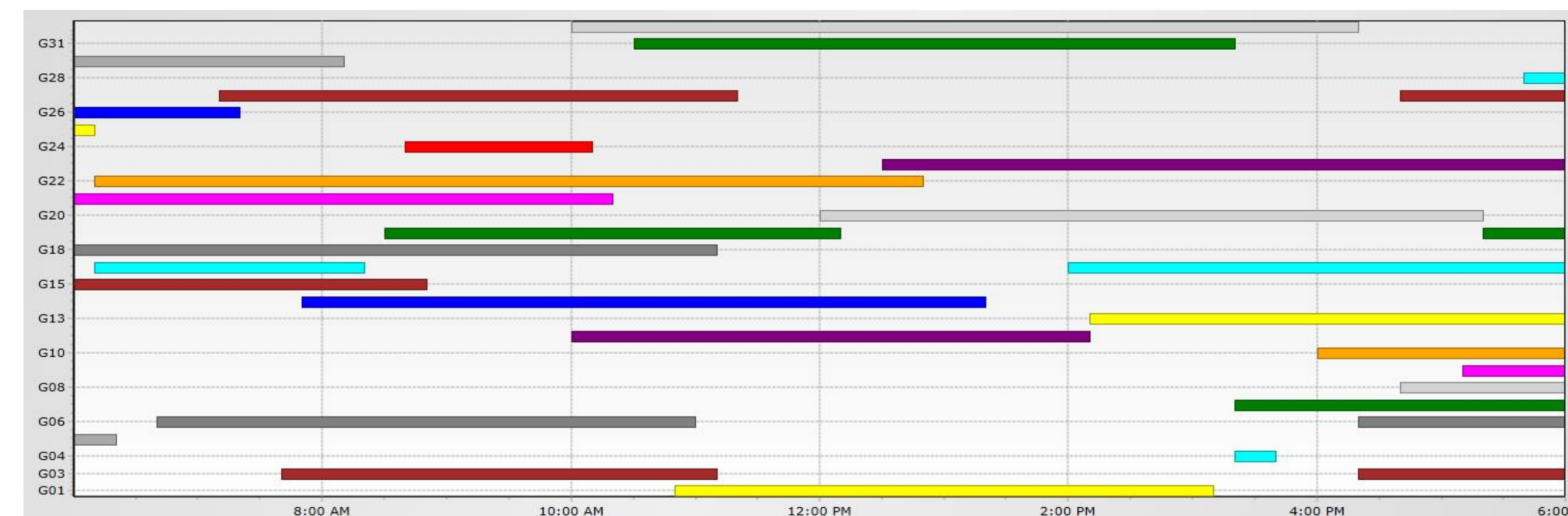
### Project Background

The San Andreas Fault system is a right-lateral strike slip fault that extends from the Salton Sea to the San Francisco Bay area. This fault is caused by the boundary of the Pacific and North American tectonic plates. The Fault has zones that are locked and that creep. Surface displacement can be monitored to determine accurate locations of survey monuments.

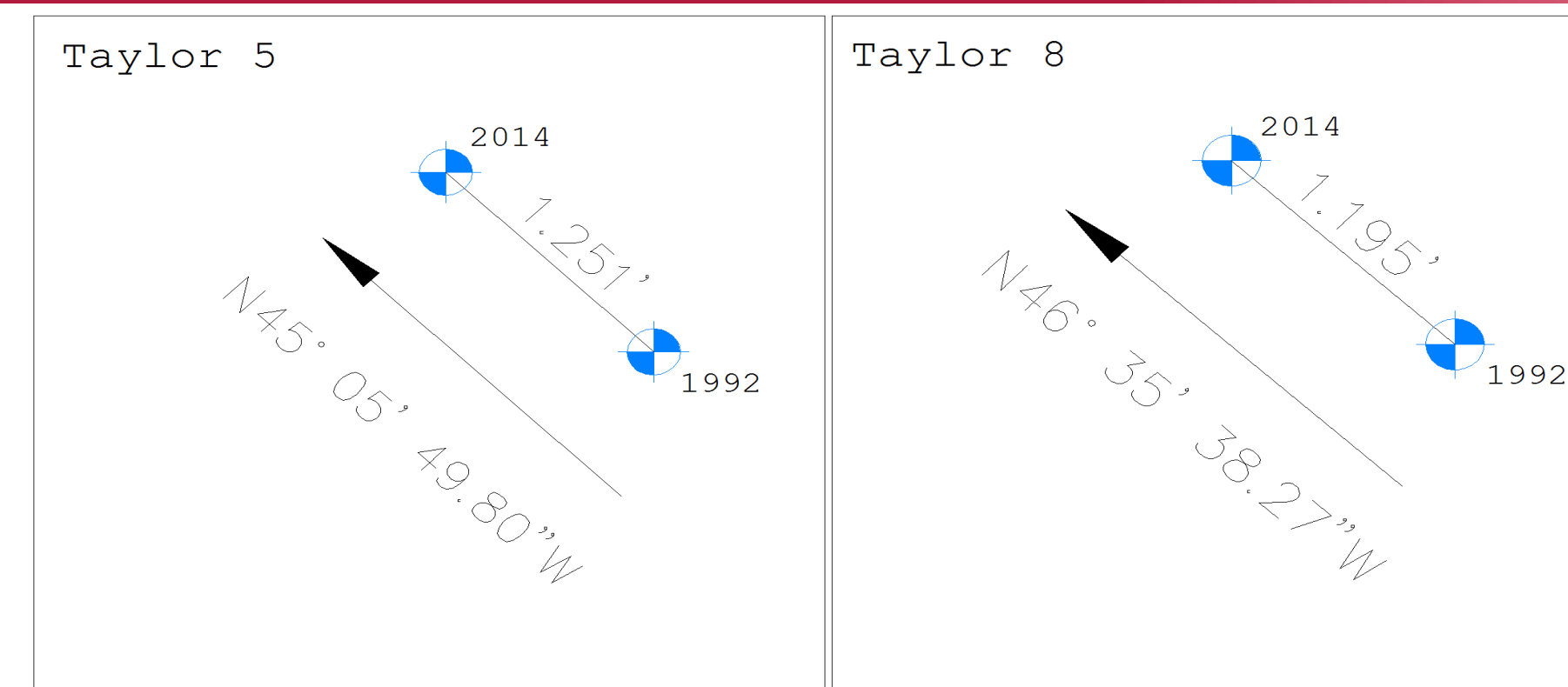


### Observational Planning

Using the Planning tool in Trimble Geomatics Office (TGO), the satellite visibility diagrams were created to plan the three observation sessions. This is done to ensure the most available satellites are used while collecting data. The obstructions to the points were included to ensure the minimum of four satellites were available.

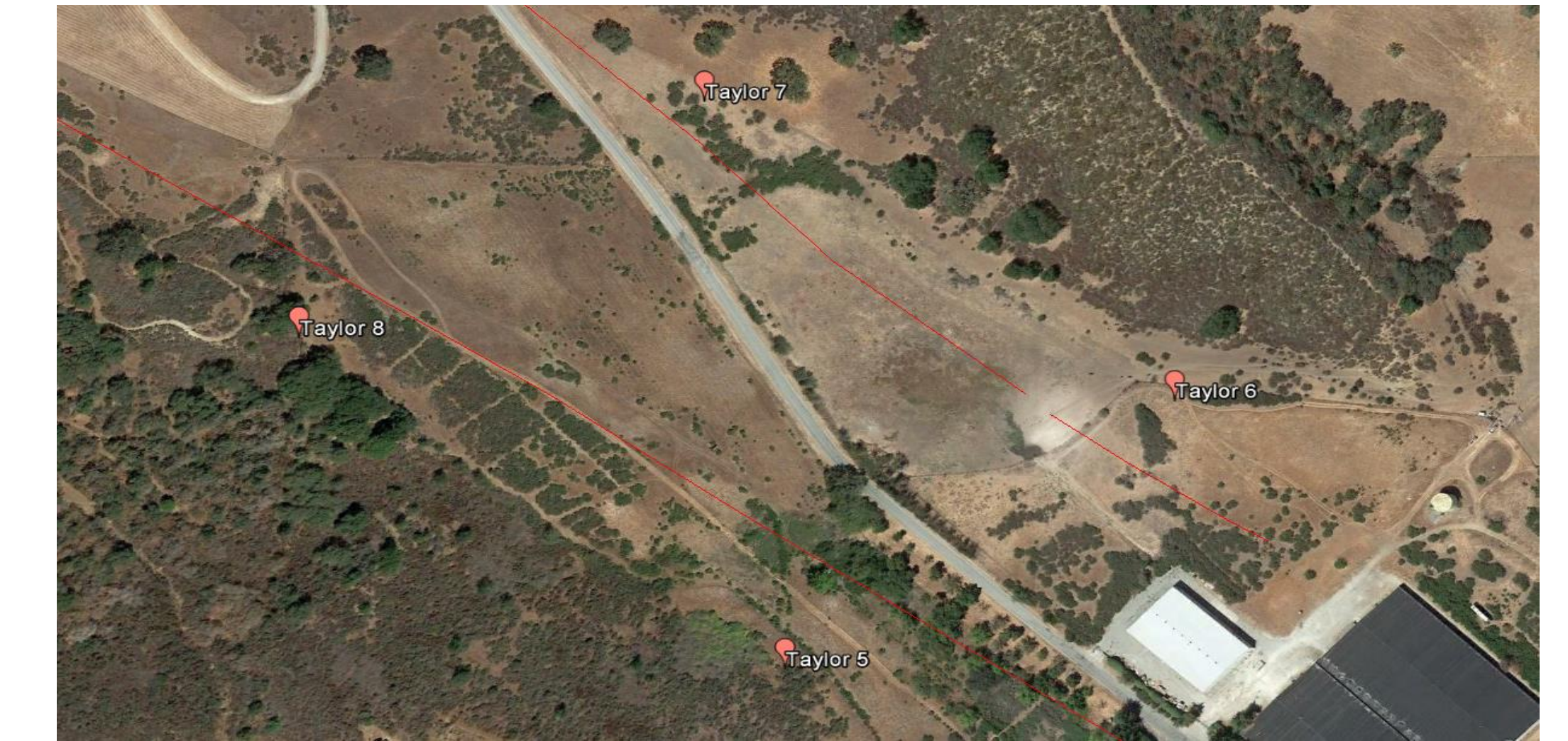


### Comparative Analysis



Coordinates of the North American plate side of the fault were fixed. From this the coordinates of the points Taylor 5 & 8 are compared from the 1992 adjusted positions and compared to the 2014 observations. From the comparison of the point locations, the movement was averaged in both distance and direction. This shows the fault motion in this area.

### Project Area



Near the DeRose Winery, 8.8 miles south of Hollister, California, four National Geodetic Survey (NGS) monuments (Taylor 5, 6, 7, & 8) were set in 1957. They were originally Purposed to monitor movement in the area, and two points lie on either side of the fault zone. The points have coordinates that were adjusted in 1992.

### Data Acquisition



On February 28<sup>th</sup>, 2014 Jacob Andresen, Alex Frantz, and Touko Vue assisted in the collection of the data. Using four Trimble R8 receivers, the points were observed 3 times, starting at 8 a.m. 10:30 a.m. and 1:30 p.m. with static GPS.

### Conclusion

Data comparison shows the fault shifted an average of 1.223 feet (37.277 cm) with a bearing of N 45° 50' 44.037" W in the 22 year period. The creep of the fault in this area was determined to be 0.0556 feet (1.694 cm) per year. The result is consistent with the 1.2397 feet (37.786 cm) of displacement estimated by the Horizontal Time-Dependent Positioning (HTDP) utility provided by the NGS.

The use of static GPS observations provide for precise determination of point location. GPS is common today as it is cost effective, accurate, and allows positioning in nearly inaccessible areas possible.

More detailed planning and more time would have allowed for more reliable data; however, the positions are within 95% confidence.