2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
1 Dec 92	ANNUAL/1 Jan 91 - 30 Sep 92

4. TITLE AND SUBTITLE
CRUSTAL DEFORMATION MEASUREMENTS IN THE VICINITY OF VANDENBERG AIR FORCE BASE

5. FUNDING NUMBERS
PE 61102F
PR 2309
TA A2
GR AFOSR-89-0400

(2)

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8. PERFORMING ORGANIZATION REPORT NUMBER
AFOSR-TR- 92 0330

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Office of Scientific Research/NL
Building 410
Bolling AFB DC 20332-6448
(Dr Stanley Dickinson)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release;
distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Recent geological and geodetic studies have suggested that the region surrounding Vandenberg AFB is undergoing active crustal deformation, with important implications for both the geodetic stability and the seismogenic potential of the Western Test Range (WTR). Part of the evidence for significant deformation was obtained from GPS measurements which we carried out in cooperation with other university and government scientists beginning in 1986. These measurements have been made annually over a broad region of central and southern California but are of insufficient spatial and temporal density to answer many questions about the seismogenic potential of Vandenberg. In March 1992 we remeasured the relative positions of the Vandenberg network stations occupied in our experiments of February and September 1990, and also established nine new stations to densify the network. The Vandenberg PGGA station has been acquiring data almost continuously since 22 May 1992, and provided an important anchor site for measuring far-field displacements from the Landers (M_w7.3) and Big Bear (M_w6.2) earthquakes of 28 June.

14. SUBJECT TERMS

15. NUMBER OF PAGES
4

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
(U)	(U)	(U)	UNLIMITED

Crustal Deformation Measurements in the Vicinity of Vandenberg Air Force Base

Grant AFOSR-89-0400
(MIT OSP No. 72373)

Annual Technical Report

for the period

1 January 1991 – 30 September 1992

Submitted to

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24 November 1992

BACKGROUND AND OBJECTIVES

Recent geological and geodetic studies have suggested that the region surrounding Vandenberg AFB is undergoing active crustal deformation, with important implications for both the geodetic stability and the seismogenic potential of the Western Test Range (WTR). Part of the evidence for significant deformation was obtained from GPS measurements which we carried out in cooperation with other university and government scientists beginning in late 1986. These measurements have been made annually over a broad region of central and southern California but are of insufficient spatial and temporal density to answer many important questions about the seismogenic potential of Vandenberg.

In 1989 we received funding under this grant (with matching funds from MIT) to purchase GPS receivers and to begin a series of measurements designed to determine the magnitude and spatial distribution of deformation in a region encompassing the major faults and folds within 50 km of Vandenberg. We acquired four receivers in January 1990 and carried out two-week experiments in February and September. Two additional receivers were purchased in May 1992 to be installed in continuously operating GPS stations at Vandenberg and the China Lake Air Naval Weapons Center. The Vandenberg station began operating in May and China Lake is scheduled to begin operation in December. They will become part of the Permanent GPS Geodetic Array (PGGA) in California, providing the ability to monitor not only interseismic deformation but any transient motion which might occur prior to, during, or after an earthquake.

MEASUREMENTS PERFORMED IN 1992

In March 1992 we remeasured the relative positions of eight of the Vandenberg-network stations occupied in our experiments of February and September 1990, and also established nine new stations to densify the network. The Vandenberg PGGA station has been acquiring data almost continuously since 22 May, 1992, and provided an important anchor site for measuring far-field displacements from the Landers (M_W 7.3) and Big Bear (M_W 6.2) earthquakes of 28 June. We will discuss the analysis of both the March, 1992, and the recent PGGA measurements in next month's annual report for our ongoing research grant (AFSOR 90-0339).

STATUS OF EQUIPMENT PURCHASES

Since our last annual report, we have completed the construction of a continuously tracking GPS station at Vandenberg. The monument was constructed in August 1991, and a receiver installed in May 1992. Delay in completing the installation was due primarily to unexpected delays in the availability of a receiver capable of reliable and accurate remote operation. By the time the receiver did become available, however, the cost was low enough that we could obtain two receivers for the cost we originally planned to pay for one, thus allowing an expansion of our research effort. In May, we requested and received approval for the installation of a permanent GPS station in the seismically active area around the Naval Air Weapons Center at China Lake. At that time we also visited China Lake and met with geologists who work with DOE and the Navy on the geothermal projects in the area. They were quite supportive and identified a possible site for the station on Joshua Ridge near an existing seismic station.

Completion of the China Lake station has been delayed by two unexpected developments, one technical and one administrative. The technical problem arose because the manufacturer of the communications modem (Telebit) used by our receiver discontinued its existing model in favor of a more powerful one. The receiver manufacturer (Ashtech) had not anticipated this change, and consequently the new modem will not work with the receiver. We have averted an impass by borrowing one of the old-model modems from Ashtech while at the same time lending them our new model for testing with their receiver. The administrative problem has been obtaining permission from the commander at China Lake to install a cellular phone at our chosen site. We had been told that this would be a relatively easy procedure, but it took over two months.

We now have both a modem and permission and plan to install the station in mid-December. The one remaining uncertainty is the effort that will be required to construct a stable monument for the GPS antenna. If we can find near-surface bedrock at a location free of reflective surfaces (which disturb the radio reception), then a steel pin cemented into the rock will suffice. If near-surface bedrock is not available, we will have to construct a more elaborate monument anchored at depth, requiring the building of a steel structure and the assistance of a contractor to dig the holes and pour concrete. Our current plan is to install either a steel pin or a temporary monument in December—allowing the station to begin operation—and to return in January if necessary to construct a permanent monument.

A summary of expenditures and funds remaining in the grant is given on the following page.

Status of Funds for AFOSR 89-0400 (MIT #s 72373 / 74553) (expires 2/28/93)

Authorized amount: $306,200

Expenditures:	Budget	Expenditures thru 9/30/92
Salaries and wages	13,240	14,210
Computation	2,000	2,000
M&S (shipping, etc)	320	2,540
Travel	1,400	2,080
Benefits	5,360	5,680
Overhead	13,880	15,530
4 Trimble 4000SST receivers	270,000	145,500
Vandenberg PGGA monument		20,090
2 Ashtech P-12 receivers		53,875
Peripheral equipment for 2 receivers (computers, tripods, tribrachs, power supplies)		7,285
Telebit "World Blazer" modem for Vandenberg		780
2 data storage devices		10,000
Vandenberg GPS maintenance		395
		279,965

Current balance: $26,235

Anticipated additional expenditures :

Vandenberg PGGA station	
Rubidium oscillator	5,000
Uninterruptible power supply and switch	4,000
China Lake PGGA station	
Rubidium oscillator	5,000
Cellular phone, antenna, and modem	5,000
PGGA monument *	7,000
Total anticipated expenses	305,965

* Assumes that excavation in sediment is necessary; if bedrock is available the cost will be less