CALIFORNIA INSTITUTE OF TECHNOLOGY

SEISMOLOGICAL LABORATORY

PASADENA, CALIFORNIA

FINAL REPORT

AFOSR Contract No.:	AF-49(638)-1299
Project Title:	Study of Free and Forced Oscillations of the Earth
ARPA Order No.:	292-63 P. R. No. 64-442
Date Contract Starts:	October 1, 1963
Date Contract Terminates:	January 31, 1965
Amount of Contract:	$139,679
Project Scientist:	Dr. Hugo Benioff and Dr. Stewart W. Smith 795-8806

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The major experimental programs supported by this contract have been described in the Final Progress Report, AFOSR Grant No. 62-355 for 1 July - 30 September 1963. Those projects that were underway but not yet completed at that time will be reviewed here.

(1) Rotational Seismometer

Modifications to the initial instrument were made including a new method of transduction, described in the previous report. The device was partially successful; however, it could not be determined how well the initial design requirements of sensitivity to translational motion had been met. Compressional waves were attenuated by factors ranging up to ten. It could not be determined whether the residual amplitude in the compressional waves was an instrumental effect or an effect of inhomogeneities in the earth, since the presence of nonhorizontal boundaries in the earth could convert part of the compressional motion to horizontally polarized shear waves.

(2) Mercury Pendulum

The long-period mercury pendulum previously developed was evaluated and found to exceed conventional displacement-sensitive mechanical pendulums in both signal to noise ratio and long term stability. An additional reservoir of mercury was added midway between the end points with a servo mechanism designed to keep the mercury level constant. This prevents temperature changes from affecting the mercury level, keeping the sensitivity of the transducers constant, and making unnecessary even seasonal adjustments in the mercury level. Two mercury pendulums have been installed at Isabella within the trough housing the strain seismometers. This combination of strain and pendulum seismographs at this low noise site makes this

one of the most powerful long period seismic observatories in the world today.

(3) Strain Seismograph

A new servo transducer was developed for use with the strain seismograph and was installed on the northeast component at Isabella. This device has a greater dynamic range, and improved linearity compared with the original transducer. These characteristics make it more suitable for the measurement of earthquake strains in the presence of slowly varying secular strains.

(4) Data Analysis

a) Long-period waves from the Alaskan earthquake were analyzed for a frequency of free vibrations of the earth. Spheroidal and toroidal modes were observed on both strain seismographs and mercury pendulums. The two orthogonal strain seismographs at Isabella were used for mode separation analysis providing improved data on toroidal frequencies.

b) Two years of data from the strain seismographs at Isabella and Nana were analyzed for earth tide effects. Studies of the effects of ocean loading on the observed tides are still under way.

c) Four years of data from Nana have been analyzed for secular variations in strain. The two orthogonal strain seismographs here have been used to separate atmospheric and ocean loading effects and seasonal thermal elastic effects from tectonic strain.

Papers Published

Benioff, Hugo, "Source wave forms of three earthquakes," Bull. Seismol. Soc. Am., 53, 893-903, Oct., 1963.

Benioff, Hugo, "Earthquake source mechanisms," Science, 143, 1399-1406, March 27, 1964.

Benioff, Hugo, "A liquid mercury pendulum," Abstract, Trans. Am. Geophys. Union, 46, March, 1965.

Smith, Stewart W., "Free oscillations excited by the Alaskan earthquake," Journ. Geophys. Res., (in press).

Smith, Stewart W., "Earth tides and secular strain," in preparation.