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2. LAMONT GEOLOGICAL OBSERVATORY

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Design and Construction of a Lunar Seismograph

(NASA Contract No. NASw-82)

(NASA CR-51217; Progr. Rept. 14)

Progress Report #14

1 Oct~~ober~~ to 31 Dec~~ember~~ 1962

SUMMARY OF PROGRESS

Several theoretical studies related to the interpretation and analysis of lunar data have continued during this report period.

A paper describing the design and operational characteristics of the four-component surveyor seismograph system is in preparation and will be submitted for publication during the next report period. The abstract of this paper, "A Remotely Operated Long and Short Period Lunar Seismograph System", was appended to Progress Report #13.

A paper entitled "Theoretical Tides on a Rigid Spherical Moon", by G. H. Sutton, N. S. Neidell, and R. L. Kovach (abstract appended to Progress Report #13), has been completed and submitted to the Journal of Geophysical Research for publication.

Another paper, "Analog Analyses of Seismograms Recorded on Magnetic Tape", by George H. Sutton and Paul W. Pomeroy, has also been submitted to the Journal of Geophysical Research. Pre-publication copies of these papers have been submitted to the National Aeronautics and Space Administration. An abstract of the paper on seismogram analyses is appended to this report. Work is continuing on these studies.

Work is continuing on the modification of the Surveyor seismograph prototype. Considerable weight saving and increased structural rigidity are anticipated.

As a result of the designation of the short period vertical seismograph as a back-up instrument for early surveyor flights, a preliminary design evaluation is presently being conducted. The seismometer will be, essentially, the short period vertical component of the four-component prototype.

Several modifications and additions are required. Inasmuch as definitive information on the location, orientation, and operational integration of the seismograph (as a back-up instrument) is not available at present, considerable flexibility is to be incorporated into the design.

It is considered essential, for example, that the system be designed in such a fashion as to permit its ready adaptation to the spacecraft once a location is selected.

Absence of firm data on spacecraft resonances prohibits making a firm decision regarding the feasibility of fixing the seismograph to the spacecraft (as opposed to lowering it onto the lunar surface). Present designs reflect the two possible operational orientations.

Engineering evaluations indicate that the seismograph electronics ought to be incorporated into the thermally controlled spacecraft electronics chambers. However, if this requires major modifications in the spacecraft, the electronics can be packaged with the seismometer.

Such unresolved questions are reflected in the design of the seismograph system and the related analyses.

Thermal analysis of the seismograph-moon system indicates a temperature range similar to that predicted for the full seismograph. This range depends on the location of the electronics.

A surface adaptor is being designed to minimize the off level of the seismograph if it is to be lowered to the lunar surface. Clamping mechanisms for adapting the instrument to the spacecraft are also being considered.

Analog Analyses of Seismograms Recorded on Magnetic Tape

by

George H. Sutton and Paul W. Pomeroy

ABSTRACT

Routine recording of long period seismometer signals on analog magnetic tape permits the rapid and efficient performance of a wide variety of analyses. Examples of analog analyses of seismic waves from eight distant earthquakes, a large nuclear explosion, and the microseism storm associated with a hurricane illustrate some of the advantages of this type of recording. Inverse and selective filtering, with and without filter phase shift, are used to remove instrumental effects, improve signal-to-noise, and emphasize desired phases. Fourier, energy and power spectra are obtained by several analog methods. Comparison of results of an analog Fourier analysis of the Palisades record of a large USSR nuclear explosion near Novaya Zemlaya in 1961 with digital analyses of two smaller 1958 explosions in the same area recorded at Palisades shows remarkable similarity in the spectra. The only significant difference between the two sets of data is that the larger event is richer in long period energy. Plots of frequency versus time and cumulative signal, in different frequency bands, versus time present seismic data in a form more convenient for certain studies than the conventional record. Various combinations of

the original three-component signals (N-S, E-W, and Vertical) permit easy identification of seismic wave types by surface particle motion; improve the precision and reliability of seismic arrival picks; and aid in the detailed study of near station effects on seismic signals. Results from rotation of apparent instrumental coordinates to longitudinal horizontal, transverse horizontal, and vertical; multiplication of vertical and longitudinal components; and integration of this product serve as examples of the advantages of this type of data transformation. The analog magnetic tape seismograms can be digitized for any digital analyses desired using a relatively simple, automatic, low speed digitizer (two three-decimal digit readings per second).