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# A COMPUTER-BASED SYSTEM FOR INTERACTIVE PROCESSING OF EARTHQUAKE SEISMOGRAMS RECORDED ON MICROFILM

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The U.S. Geological Survey (USGS) has operated a telemetered seismic network in southern Alaska since 1971 to provide basic data necessary for the assessment of seismic risk. In its present configuration, the network consists of approximately 50 short-period (mostly vertical) seismic stations spanning southern coastal Alaska between western Cook Inlet and Yakutat Bay. Signals from these 50 seismic stations, together with signals from selected seismic stations managed by the NOAA Tsunami Warning Center and the Geophysical Institute of the University of Alaska, are recorded continuously on four Develocorders at the NOAA Tsunami Warning Center at Palmer, Alaska. The Develocorders produce four 16 mm microfilms every 24 hr, with each film containing 18 analog seismic traces plus top and bottom time codes.

Since late 1974, when the USGS southern Alaska network reached its present size of approximately 50 stations, the complete processing of a single earthquake for cataloging purposes has required a multi-step procedure which includes: (i) scanning for events; (ii) initial timing; (iii) merging and formatting of the initial timing data into a phase list suitable for input to an earthquake location program; (iv) initial computer processing; (v) remeasurement and modification as necessary of the initial phase list; and (vi) final computer processing. The details of this procedure have varied from time to time, but the major weaknesses have always been the inability to project all four 16 mm microfilms onto a common surface for timing and the long wait (up to 1 day) between the initial timing of an event and the initial computer location results. These weaknesses prevent the seismic analyst from grasping the overall pattern of seismic wave arrivals across the network, require an intermediate step to merge the timing data for every earthquake recorded on more than one film, and make it necessary to retrieve and project some films more than once if data has been missed or incorrectly measured during initial timing.

Here, we briefly describe a computer-based system for interactive processing of earthquake seismograms recorded on up to four reels of 16 mm microfilm which eliminates the major weaknesses in the multi-step processing procedure described previously. This is an important development because for the forseeable future, 16 mm microfilm will remain the principal recording media for the USGS southern Alaska seismic network. In addition, the system provides a convenient tool for special seismological research requiring repetitive waveform measurements made from microfilm. The basic system design is outlined below, and the interested reader may consult a report by Astrue *et al.* (1983) for details.

## SYSTEM DESIGN

The system consists of four major units: (i) a film transport and optical projection unit that advances and projects portions of up to four 16 mm microfilms onto a single digitizing table; (ii) a sonic digitizing unit activated by a hand-controlled cursor that allows the analyst to time seismic phases and measure waveform amplitude, period, and duration; (iii) a dedicated microcomputer that controls the

bookkeeping and processing tasks, reduces the digitized data, computes a preliminary hypocenter location and magnitude, and provides an interface with a larger computer for final processing; and (iv) a printer for permanent recording of each data analysis session, and a video display for easy monitoring of the current step in any given processing sequence. Communication with the microcomputer is accomplished via a keyboard mounted on an adjustable slide arm above the digitizing table. All optical, mechanical, and electrical problems encountered thus far have been circumvented by simple modifications in equipment and procedure.

One earthquake at a time is processed. Because all firms are projected onto a common surface, the analyst can observe the pattern of seismic arrivals across the entire network. The necessary data is digitized and a phase list is generated and input to a simplified earthquake location program (LOCATE) which computes a preliminary hypocenter, origin time, and station residuals. The objective is to use this preliminary output as a guide to obvious errors in the digitized data. The analyst controls options which allow selective remeasurement of any digitized datum while the films are still mounted; remeasurement automatically results in an updated phase list. The process is repeated until a satisfactory result is obtained from LOCATE, and then the phase list is transmitted to a larger computer where final processing is accomplished. Thus, there is no intermediate step required to merge data, and obvious errors are detected and corrected before the films are unloaded.

Currently, the final processing is done with HYPOELLIPSE (Lahr, 1980) on a VAX 11/780. The only major system modification anticipated is the installation of HYPOELLIPSE in the dedicated microcomputer so that data transmission to the VAX can be eliminated. It would then be possible to use HYPOELLIPSE for error checking, and a satisfactory run would be the final processing for the earthquake. In the current system configuration, data transmission to the VAX is sufficiently time consuming that the work reduction achieved by four-film projection is largely defeated. It is expected that elimination of this data transmission would reduce by 25 to 50 per cent the number of man-hours of processing work now required per cataloged earthquake recorded by the USGS Alaskan network.

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## References

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