Note on Long-Period Noise in Seismographs[1]

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An important source of long-period (20 to 200 sec) noise in seismographs is thermal instability of the air within the case of the seismometer. (Long-period noise associated with low or falling air temperatures was observed by Milne before 1900 [*Robertson*, 1946]). This noise can be eliminated by producing a stable air column within the seismometer case or removing the air from the seismometer case. Both methods have been verified experimentally. The exact manner by which this instability produces motions of the seismometer boom is not known and may not be the same for different instruments. The effect is often, but not always, more serious on horizontal seismometers than on vertical seismometers.

At Palisades this phenomenon was observed on long-period instruments during cold spells in the winter. The noise was completely eliminated by covering the seismometer with a styrofoam box containing, near its top, an electric light bulb for a heat source. At the author's suggestion, other investigators have also used this method [*Bogert*, 1961]. Similar results were obtained by heating the entire vault. On a developmental instrument this noise was produced by heating the base plate and eliminated by evacuating the case to about 3 to 10 mm Hg.

Figure 1 shows the build-up of this noise when vault heat is turned off. Records are shown for three instruments recording over the same period of time. A styrofoam case over the instrument delays the onset of the noise but does not eliminate it. This set of records indicates that the source of the disturbance is within the instrument case. On all records shown, points vertically below each other on successive traces are 1 hour apart.

Figure 2 again shows the build-up of noise on unprotected instruments when the heat in the vault is turned off. The undisturbed record in the center is from an instrument with a styrofoam cover-box containing a light bulb heat source at its top. The noisy 15- to 75-sec instrument has a metal case, and the noisy 30- to 100-sec instrument has a double plexiglas and aluminum cover. It can be seen on the lower (30- to 100-sec) record that the noise disappeared about two hours after the vault heating was resumed. (Each pair of numbers represents the free periods of the seismometer and galvanometer respectively.)

A distinctive form of this noise is shown in Figure 3. On occasion these nearly pure sinusoidal oscillations have persisted for several days. The reduction of the noise for about 15 minutes on the top line of the record occurred just after the vault had been entered for record changing. This indicates that the conditions required on this occasion are quite sensitive. Again the disturbance is removed by heating. This form of thermally induced noise has been observed over long periods of time in vaults in subtropical locations where the temperature range is quite small.

Note added in proof. Similar long-period noise has been observed with a short-period (1- to 2-sec) Sprengnether seismometer. The trouble was cured with heat and insulation. Since the suspended mass is small, it is not surprising that this instrument is more sensitive to air motion than other short-period seismometers (J. A. Peoples, Jr., personal communication, 1962).

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REFERENCES

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Robertson, Florence, On long-period seismographic disturbances, *Trans. Am. Geophys. Union, 27*, 11–13, 1946.

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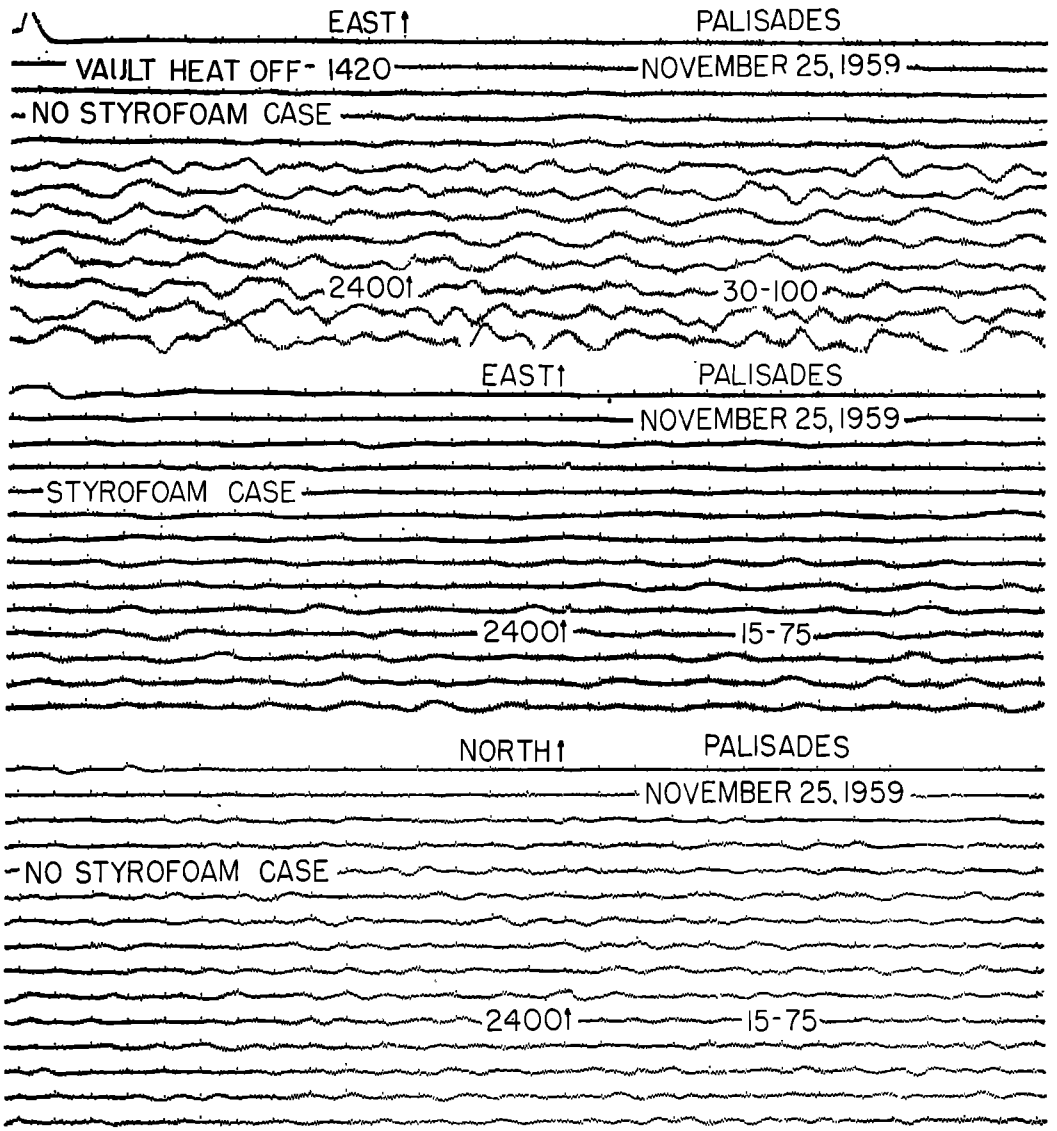

Fig. 1. Noise on three long-period seismographs produced by thermal instability of the air within the seismometer case.

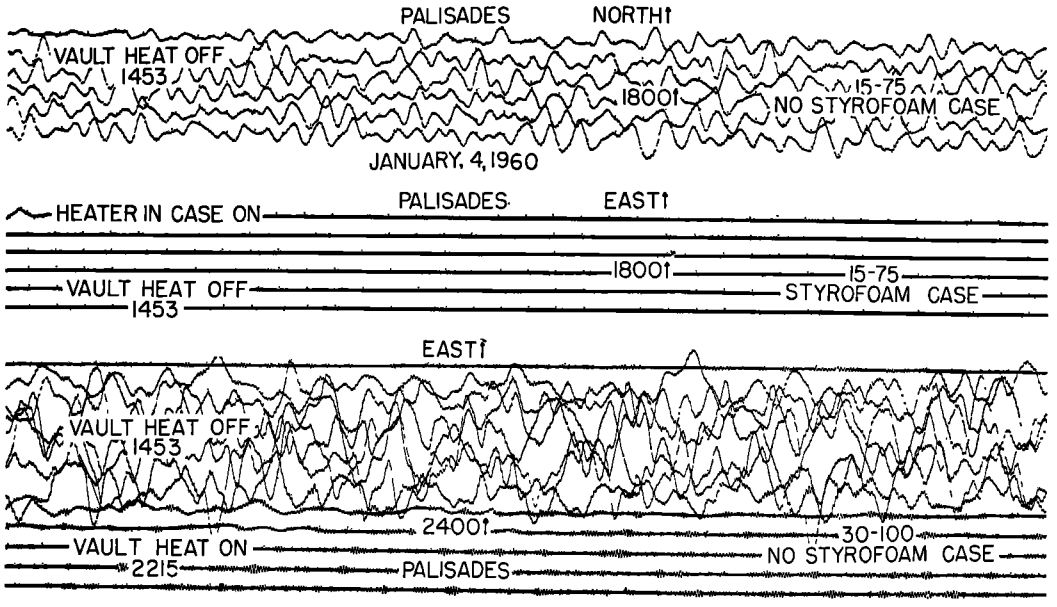

Fig. 2. Thermally induced noise on three long-period seismographs eliminated, on the middle record, by placing a heated styrofoam cover over the seismometer. Note that, on the two upper records, recording was started after the heat was turned off and stopped before it was resumed.

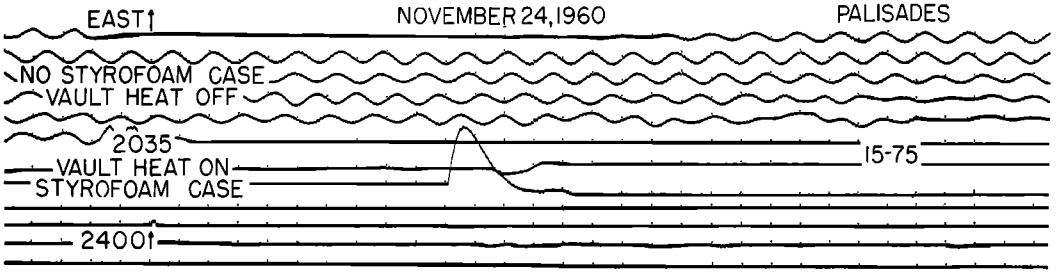

Fig. 2. Sinusoidal thermally induced noise on a long-period seismograph.