RELATIONSHIP BETWEEN MICROSEISMS, GEOMAGNETIC ACTIVITY AND IONOSPHERIC ABSORPTION OF RADIO WAVES

JAN LAŠTOVIČKA

Geophysical Institute, Czechosl. Acad. Sci., Prague)*

Summary: *Relatively good correlation between such remote phenomena as microseisms, geomagnetic activity and ionospheric absorption of radio waves has been observed. These phenomena are probably connected by a considerably increased penetration of energetic particles into the atmosphere under conditions of geomagnetic activity.*

It is well known that the seismograph, besides earthquakes, also records other motions (oscillations), which are generally called "seismic noise". The seismic noise in the range of periods of about 1—10 s is called "meteorological microseisms" (hereafter only microseisms), because it is caused by changes of atmospheric pressure fields and by cyclonal activity above large water areas, mainly above the oceans.

The study of microseisms, recorded at the Prague seismic station, showed that the annual average periods of microseisms appear to exhibit a considerably pronounced four-year variability [1]. The origin of this variability has not been clarified. It has not been observed in the solar activity indices [2]. A significant periodicity with $T = 4{\cdot}1$ years was, however, recently observed in the spectrum of monthly average values of the geomagnetic activity index Ap [3]. Therefore, the comparison of periods of the microseisms with the corresponding values of the Ap index is carried out in this paper.

Prague microseisms can be evaluated only in so-called "active periods" (September—May) due to a very pronounced annual variation of their amplitude. The average values of the microseismic period T, Ap index, solar activity indices R (sunspot number) and $F_{10{\cdot}7}$ (solar radio noise at $\lambda = 10{\cdot}7$ cm, i.e. $f = 2800$ MHz), and ionospheric absorption of radio waves measured by the A3 method at the Průhonice Observatory at sunset [4] for active periods 1948/49—1965/66 are shown in Fig. 1. It follows from Fig. 1 that the Ap index corresponds to year-to-year changes of microseismic period much better than the R and $F_{10{\cdot}7}$ indices. This can be seen particularly in the case of sudden steep peaks in the years 1951/52, 1959/60 and 1963/64, which are not observed in the R and $F_{10{\cdot}7}$ indices. The correlation coefficients also confirm an evidently better relation between the microseismic period and the Ap index: $\varrho_{T,Ap} = 0{\cdot}74$, $\varrho_{T,R} = 0{\cdot}54$ and $\varrho_{T,F_{10}{\cdot}7} = 0{\cdot}52$. Assuming linear dependence, the relationship between T and Ap, R and $F_{10{\cdot}7}$ was calculated by the least-squares method:

$$(1);\ (2) \qquad T[\mathrm{s}] = 0{\cdot}039Ap + 0{\cdot}0015F_{10{\cdot}7} + 3{\cdot}85\,; \quad T[\mathrm{s}] = 0{\cdot}040Ap + 0{\cdot}0011R + 3{\cdot}39\,.$$

Taking into account the observed variability of the Ap, $F_{10{\cdot}7}$ and R indices (Fig. 1), the dominating role of the Ap index in microseismic variability can again be seen — the change of Ap from minimum to maximum values causes a change of T about three times higher than the same change of the R or $F_{10{\cdot}7}$ indices. The microseismic amplitude has a time pattern like the microseismic period with the same strong peaks, e.g. 1951/52. It is interesting that the ratio of the microseismic amplitudes I_{NS}/I_{EW} has a time pattern similar to the microseismic periods with the same peaks.

Figure 1 shows a somewhat surprising fact — the ionospheric absorption of radio waves at the frequency of 272 kHz measured at sunset, which characterizes the state of the lower ionosphere

*) Address: Boční II, 141 31 Praha 4 - Spořilov.

within an altitude range of about 80—90 km, seems to correlate with the microseismic periods even better than the *Ap* index. If *Ap*, ionospheric absorption and microseisms are well correlated mutually, a factor probably exists, which is able to connect them.

This factor can be energetic particles. Their penetration into the atmosphere is very enhanced under conditions of geomagnetic activity (storms) [5]. Penetrating particles cause some increase of absorption (observed mainly at night and around twilight) due to additional corpuscular ionization. Both the immediate effect and mainly the after-effect, delayed by a few days, are observed (e.g. [6]).

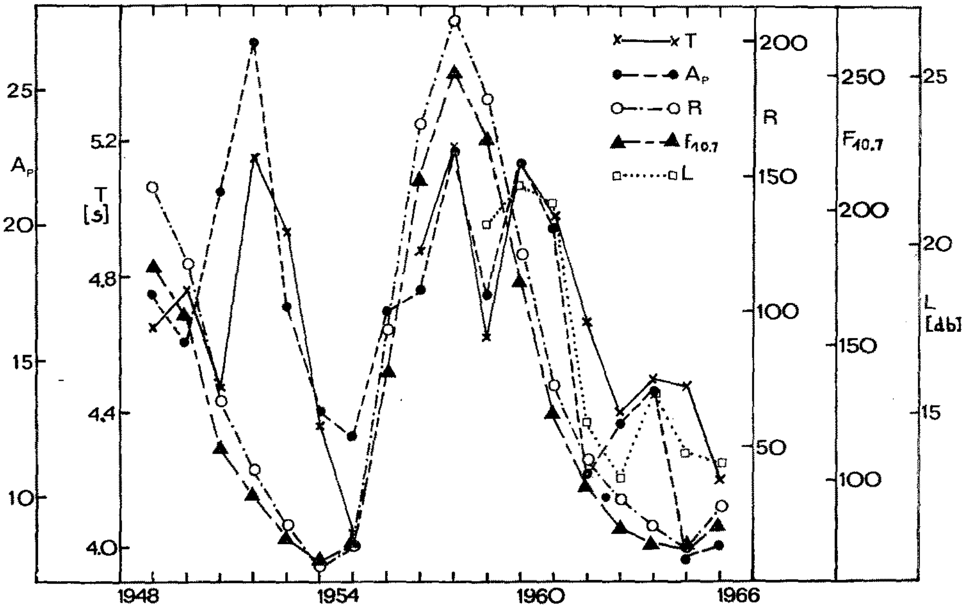

Fig. 1: Mean "active period" values of the microseismic period T(s), geomagnetic activity index *Ap*, sunspot number R, solar radio noise intensity at $\lambda = 10{\cdot}7$ cm (Ottawa) $F_{10\cdot7}$ and the sunset radio-wave ionospheric absorption on 272 kHz L(db). 1948/49—1965/66.

Now there are strong indications that solar corpuscular emission affects the large scale atmospheric circulation in north hemisphere winters at high and intermediate latitudes [7]. Such changes of atmospheric circulation would be likely able to change the microseismic activity. As one of the several possibilities, the following tentative hypothesis, explaining the observed relation between geomagnetic and microseismic activity, can be suggested:

The major source of the Prague microseisms are the following regions: to the southwest of Iceland, around the Jan Mayen Island and the northern part of the Baltic Sea for longer periods, and the central and north Norwegian coast for shorter periods [8, 9]. After a geomagnetic storm an increase of atmopsheric pressure is observed over the Icelandic region and then above Scandinavia [10], i.e. these two regions cannot significantly produce microseisms. It can cause the observed increase of microseismic periods due to the exclusion of the Norwegian short-period region and also an increase of the amplitude ratio I_{NS}/I_{EW} due to the exclusion of the most westerly located Icelandic region. This tentative hypothesis must be checked and supported by further evidence.