TIDAL RESEARCH AND SEISMICITY

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ABSTRACT

Several aspects of the tidal deformations may be of interest in seismicity analyses: possible earthquake triggering, dilatancy monitoring, precursor observations. Oceanic tides even may be more important than solid earth tides provided their loading effects.

While instrumentation should more and more be set towards real time observations, it should be great if more young scientists could be involved in seismological research in Europe.

Tidal research and observation may be relevant to seismology in the following three aspects.

1 - It is a rather popular belief that tidal stresses in the crust can trigger earthquakes. As regards this many papers have been published in order to prove the existence of such a correlation. More, moonquakes having undoubtedly revealed a tidal effect, the problem for the earth has been revived deeply.

2 - As well known, the dilatancy process affects the velocity of seismic waves and thus appears as one of the most important precursors of earthquakes. Obviously the tidal deformations should be affected in a similar way. Beaumont and Berger (1974) indeed have shown that when the ratio $V_p/V_s$, for waves travelling through a region affected by dilatancy, may vary by some 15 %, then the corresponding effect in tidal tilt and
stress might be of the order of 60 %. Such observations will have the great advantage as regards the seismic phenomena that tidal deformations will be a permanent process allowing continuous monitoring of dilatancy.

3 - As the tidal instrumentation (as gravimeters, tiltmeters and extensometers) generally has a natural period in the low frequency domain, these instruments may be considered as good detectors for some typical forerunners of earthquakes. However, up to now, no clear example can be given.

In order to make clear that the above mentioned applications raise some difficulties, we should remind the main features of the tidal phenomenon for what concerns their amplitudes and frequencies.

A fully detailed treatment of the tidal waves is given in Melchior (1978).

Concerning the amplitudes of the tidal phenomena, their magnitudes are in the order of
0.5 m. in radial displacement (vertical), or
0.2 mgal, i.e. 2.10^{-7} g in gravity,
0.002 in tilt
2.10^{-8} in cubic dilatation or linear strain, and about
10 mbars in stress.

As regards the frequencies, these are mainly divided in three "families" each of them having a different impact on the rotation of the Earth:
- the semi-diurnal (sectorial) waves with a period of ca 12 h and is responsible for the secular retardation of the Earth's rotation;
- the diurnal (tesseral) waves, having a period of ca 24 h and responsible for the precession nutation of the Earth's axis of rotation;
- the 14 d, 28 d, 6 months and on year period or zonal waves implying periodic variations in the Earth's speed of rotation.

These different families are latitude dependent for their three usual components (Vertical, NS and EW) what increases the difficulties for setting out a correlation in time between the earthquake occurrence and the maximum amplitude of the tide. This indeed depends upon the chosen component and at which latitude the seismic activity is considered.

For these reasons it is easier to establish a correlation in tropical areas by taking the vertical component or the cubical dilatation as the tidal curve for these components is a very regular one at low latitudes.