

ABSTRACT

“TILDEindeep”

Over a century of geophysical and tectonic observations have provided a partial view of the dynamics of the solid Earth, which most of the scientific community today interprets in light of plate tectonics. However, many questions remain unanswered. One of the most intriguing concerns the causes and mechanisms driving plate motion, a fundamental problem for understanding all the geological phenomena we observe on our planet. For years, several inconsistencies between theoretical models and experimental data have been ignored, including the "western" polarization of plate motion relative to the mantle, the asymmetry of subduction zones, and the existence of a tectonic equator whose inclination, determined by the sum of the ecliptic and the lunar tilt ($\approx 23.5^\circ + 5^\circ$), remains completely unexplained. Lunisolar tides have often been invoked as the driving force of plate tectonics and earthquakes, but, until now, a direct correlation has never been demonstrated. A correlation has been found between the behavior of Solid-Earth Tides and the existence of the tectonic equator. Seventy-three GNSS stations distributed worldwide, accumulating a time series of data spanning at least 20 years, were analyzed. The data were processed using Precise Point Positioning mode, which provides the absolute displacements of the stations. These data are used to estimate, for each station, the Love and Shida Numbers of the principal Long-Period Tides: 18.6 years, semi-annual, monthly, 13.63, and 13.66 days; as well as the principal K1 daily tides and M2 semi-daily ones. The results show that Solid Earth Tides exhibits a local behavior dependent on the location of the stations. Earth's deformations are not uniform and can differ from one location to another due to interactions with the Earth's crust and its local properties. Local Solid Earth's Tides are precisely measured using geodetic instruments such as ground network of Global Navigation Satellites Systems (GNSS) receivers.

In this first study a meaningful correlation between Long Periodic Tides and station latitudes has been found. Love Number values reach their maximum values precisely along the tectonic equator. However, so far, these findings should be considered only preliminary results. More robust confirmation is needed. A larger number of GNSS stations regularly distributed around the world, with a longer time span, must be analyzed to obtain definitive confirmation of this trend.

Furthermore, the same study conducted on regional GNSS networks in seismic-prone areas appears to show a very interesting correlation between seismic events and Love Numbers values. Seismic events occurred immediately after local Love Number minima. Lower Love Number values indicate that the Earth's crust is more rigid. Therefore, there may be a correlation between Earthquakes and tidal Love Numbers. Again, a broader range of cases and a larger volume of data are needed.

The work we plan to carry out will be developed according to the following steps:

1. Learn to use GNSS processing software such as Bernese or equivalent tools.
2. Collect at least 20 years of data from at least 500 GNSS stations worldwide to confirm the correlation between tectonic plate movements and lunar tides;
3. Collect at least 5 years of GNSS data from stations located in areas where significant seismic events have occurred to demonstrate their occurrence correlated with LN values;
4. Process all GNSS data in PPP mode;
5. Define the optimal numerical strategy for Love Number estimation;
6. Evaluate the possible use of artificial intelligence and machine learning algorithms to understand whether these tidal parameters can be used as seismic precursors.