SHORTER CONTRIBUTION

A tidal period of 1800 years

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The Swedish oceanographer O. Pettersson has presented evidence indicating that the last maximum of oceanic tides occurred about 1433. He pointed out that there is a coincidence between a tidal period of 1800 years and climatic changes of the same period. We think we can explain this period as follows.

The time the Earth needs to move in its elliptical orbit around the Sun from the perihelion back to this point is 365.259 641 340 days. This period is the well known anomalistic year.

The line of nodes, the intersecting-line of the plane of the Earth's orbit and the plane of the Moon's orbit moves in a direction (westwards) that is opposite to the lunar movement. The angle described in the plane of the Earth's orbit by the line of nodes is 0.052 953 922° a day, or 19.3414° a year, thus one revolution is made in 18.61 years. When the line of nodes stands in the direction Sun–Earth, Sun, Earth and Moon will be situated on one line twice a month. During this particular period the gravitational forces of Sun and Moon on the Earth will be more intensive than in other times.

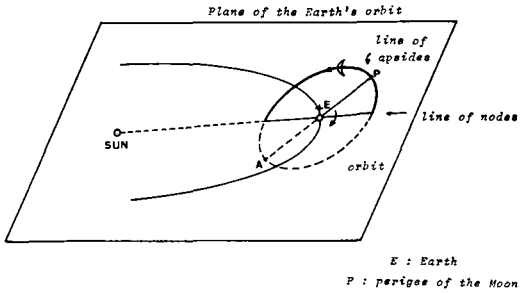

Fig. 1. The line of nodes of the lunar orbit coincides with the line Sun-Earth.

The line of apsides, the major axis of the Moon's orbit, moving in the same direction as the Moon to the East, describes an angle of 0.111 404 080° a day or 40.69° a year, thus one revolution is made in 8.84 years. If both the line of apsides is in the direction of Earth and Sun and the perigee is situated between Sun and Earth the influences of Sun and Moon on the Earth will reach a relative maximum once a month by New Moon (viz., when the Moon is in its perigee).

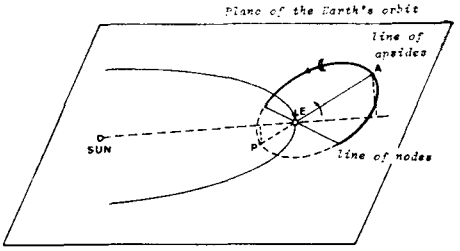

Fig. 2. The projection of the line of apsides on the ecliptic coincides with the line Sun-Earth.

If at the same time this moment of maximum influence coincides with the moment at which the Earth is in the perihelion of its orbit, the tides will reach an absolute maximum.

We will now consider how often such a situation of maximum tides will occur. The perigee moves 0.164 358 002° a day relative to the node, corresponding to 360° in a period p = 2 190.340 565 days. So, when the perigee of the Moon's orbit coincides with the ascending node, then this situation repeats after 2 190.340 565 days. This period p corresponds to 5.996 667 350 anomalistic years, thus *nearly* an entire number of anomalistic years. A period of 300 p corresponds to 17.990 002 050 anomalistic years, hence, to exactly an entire number of anomalistic years.

Thus it can be said that after exactly 17.99 centuries the coincidence of the perigee and the

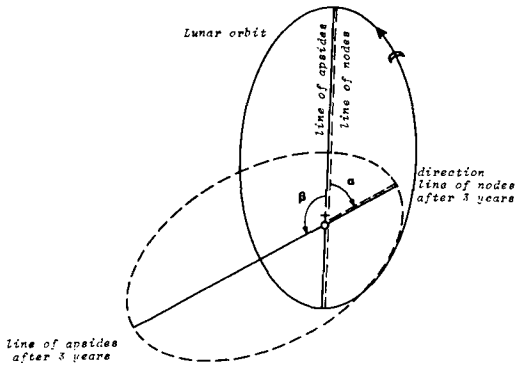

Fig. 3. After three years the line of nodes has turned over an angle $\alpha = 3 \times 19^{\circ}3414 = 58^{\circ}0242$, whilst the line of apsides described an angle $\beta = 3 \times 40^{\circ}69 = 122^{\circ}07$. Hence we have $\alpha + \beta \approx 180^{\circ}$.

ascending node occurs on the same day of the anomalistic year.

So, if this coincidence also coincides with the moment of perihelion passage of the Earth in its orbit, this situation of double coincidence will repeat after exactly 1799 years. Hence, only once in about 1 800 years the line of nodes and the line of apsides (the Moon in its perigee) coincides with the major axis of the Earth's orbit and the position of the Earth in the perihelion. In case of this double coincidence, the tidal forces exerted by Sun and Moon will reach an absolute maximum. Every nine years afterwards, the coincidence of the line of nodes and the line of apsides deviates more and more from the direction perihelion–Sun and finally after 900 years a situation will occur when line of nodes and line of apsides coincide with the moment at which the Earth is at its aphelion. In this case a minimum of gravitational forces from Sun and Moon will occur.

Other less intensive maxima are superposed on the period of 1800 years. They are caused by a coincidence of the line of nodes and the line perihelion–Sun as well as a coincidence of the line of apsides and the line perihelion–Sun.

In view of the present explanation we may expect the next maximum of tidal action about the year 3233 and the minimum about 2333.

REFERENCES

Pettersson, O. 1912. Klimatförändringar i historisk och förhistorisk tid. *Kungl. Svenska Vetenskaps-akademiens Handlingar*, Bd. 51, no. 2.