Earthquake prediction for South-Central Alaska has been fulfilled

Lubor Ostřihanský
Nad Palatou 7
150 00 Prague 5
Czech Republic
ostrh@tiscali.cz

Abstract
Using confirmed long term tidal periodicities, it has been predicted that the next strong earthquake in South-Central Alaska, situated in narrow belt 149º-146ºW and 60º-65ºN will be in 2021, what has been fulfilled by earthquake Chickaloon May 31, 2021 M 6.1. Record of earthquakes proves that no other earthquake has occurred in investigated area in period 2002 – 2021 over 6th magnitude except starting Denali Fault Nov. 3, 2002 and ending Chickaloon May 31, 2021. Owing to position on shelf of Gulf of Alaska and starting position on subduction, it is supposed that also the great earthquake Chignik 29.7.2021 M 8.2 has been triggered by tides.

Introduction
Tidal influence on earthquakes triggering is mentioned by many geophysicists since introducing the plate tectonics as e.g. Moore 1973, Bostrom 1971, Ostřihanský 1978. More recent contributions present Tanaka et al 2012, Cochran et al 2004, Metevier at al 2006, Riguzzi et al 2009 and Van der Elst 2016. Most of mentioned authors use robust statistics to proof result but they are mostly unconvincing. Only author (Ostřihansky 2021) has shown when tide can trigger earthquakes and when Moon and Sun tides act contra productively. In the project of Earthquake prediction the author presented prediction in June 2017 that the next strong earthquake in South–Central Alaska will be in 2021. This paper has been submitted to Geophysical Journal International and in this form is available on ResearchGate.

Long time distribution of earthquakes.
Tidal torques are dependent on Moon and Sun declination and because Moon's declination reaches maximum value ±28.725º in major lunar standstills (September 1969, May 1988, June 2006, April 2025 and September 2043), this offers possibility for earthquake triggering prediction. However owing to action of tidal friction force these periods in Alaska are shifted for 4 or 5 years sooner.
Fig. 1 shows distribution of earthquakes since 1962 up to 2021 with graph of Length of day variations (LOD), i.e. Earth's rotation speed, which does not cause earthquake triggering but is caused by the same tidal parameters as earthquakes and plate movement. For understanding the subject of the paper the author recommends to reed paper Ostrihansky 2021, where values of tidal energy and mechanism of the plate movements are explained.
For investigation the narrow 3º belt was chosen in continental Alaska covering area 149º-146ºW and 60º-65ºN of Denali Fault and Prince William Sound (Fig. 3).
Looking at Fig. 1, it is evident those large earthquakes occur in long term periods: in 19 years Metonic cycle or in nodal Moon 18.61 years cycle. Distribution of big earthquakes is not exact. Time span between 1964 and 1983 is 19 years and 4 months, 1983 – 2002 is 19 years and 4 months and 2002 – 2021 18 years and 5 months,
Fig. 2 shows that really the first strong earthquake over 6 magnitude after previous maximum 2002 is Chickaloon May 31, 2021 M 6.1.

To solve the problem with tidal earthquakes inaccuracies, records are presented of 2021, 2002, 1983 and 1964 (Figs. 4. 5, 6 and 7).
Record (Fig. 4) shows that the earthquake Chickaloon 2021 is situated exactly on LOD minimum, what confirms maximum north-south tidal torque triggering, which causes immediate earthquake triggering. Earthquake on Denali Fault from 2002 shows correlation of earthquake with LOD maximum and previous maximums indicate action of resonance with 5 strokes increasing tidal effect but also delay of earthquake triggering. For this reason the period 2002-2021 is shorter.

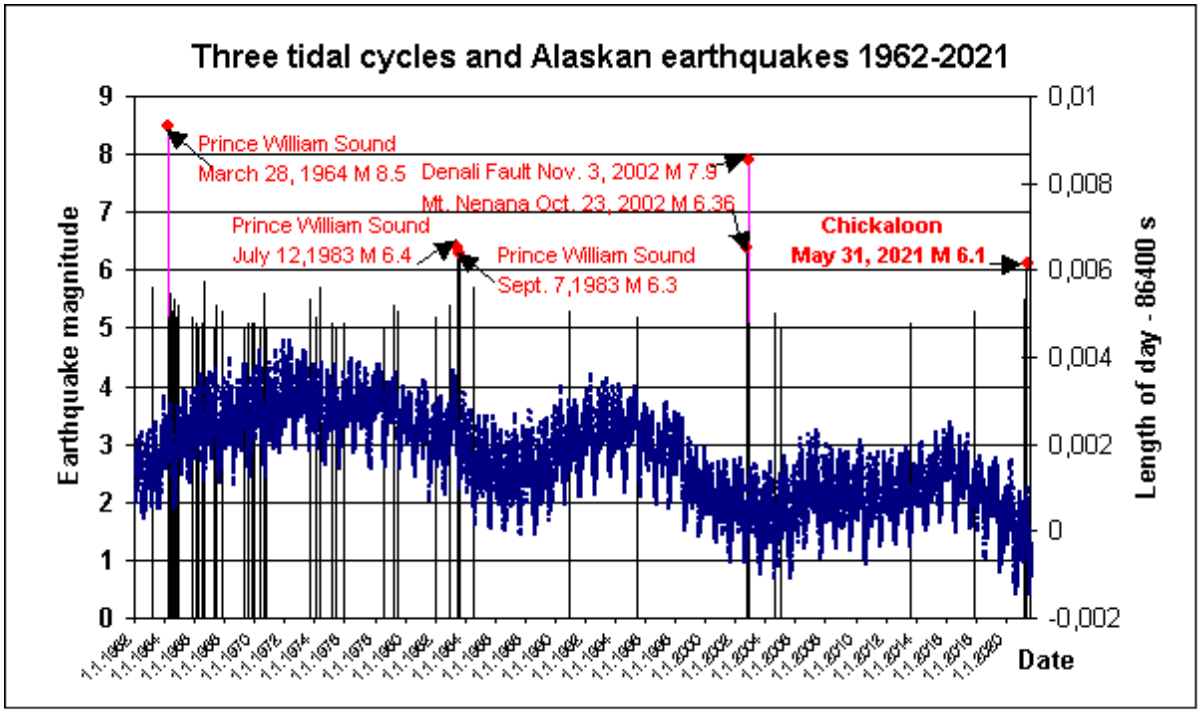

Figure 1. LOD graph and position of earthquakes in period 1962 – 2021. Positions of the largest earthquakes correlate with long time tidal variations: Moon nodal 18.61 years variation or Metonic 19 years cycle.

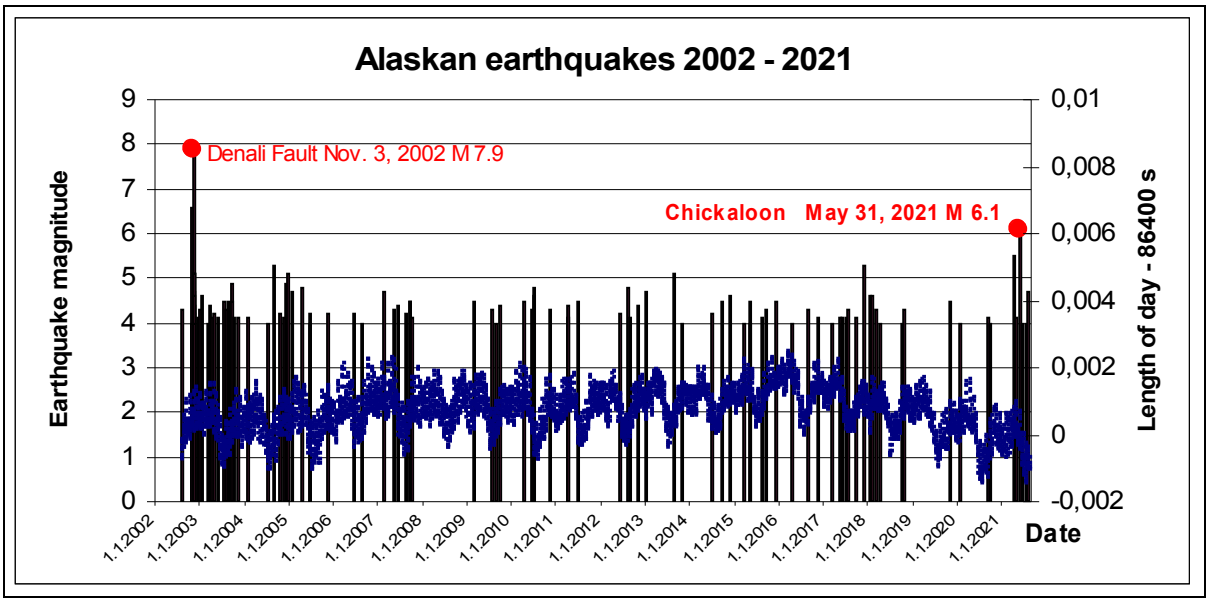

Figure 2. The proof that no other earthquake over 6th magnitude has occurred in period

2002 –2021, which started with Denali Fault earthquake Nov. 3, 2002 M 7.9 and ended by earthquake May 31, 2021 M 6.1 of chosen area on Fig. 3. It is evident that strong tides, which torques periodically vary, trigger strong earthquakes.

t

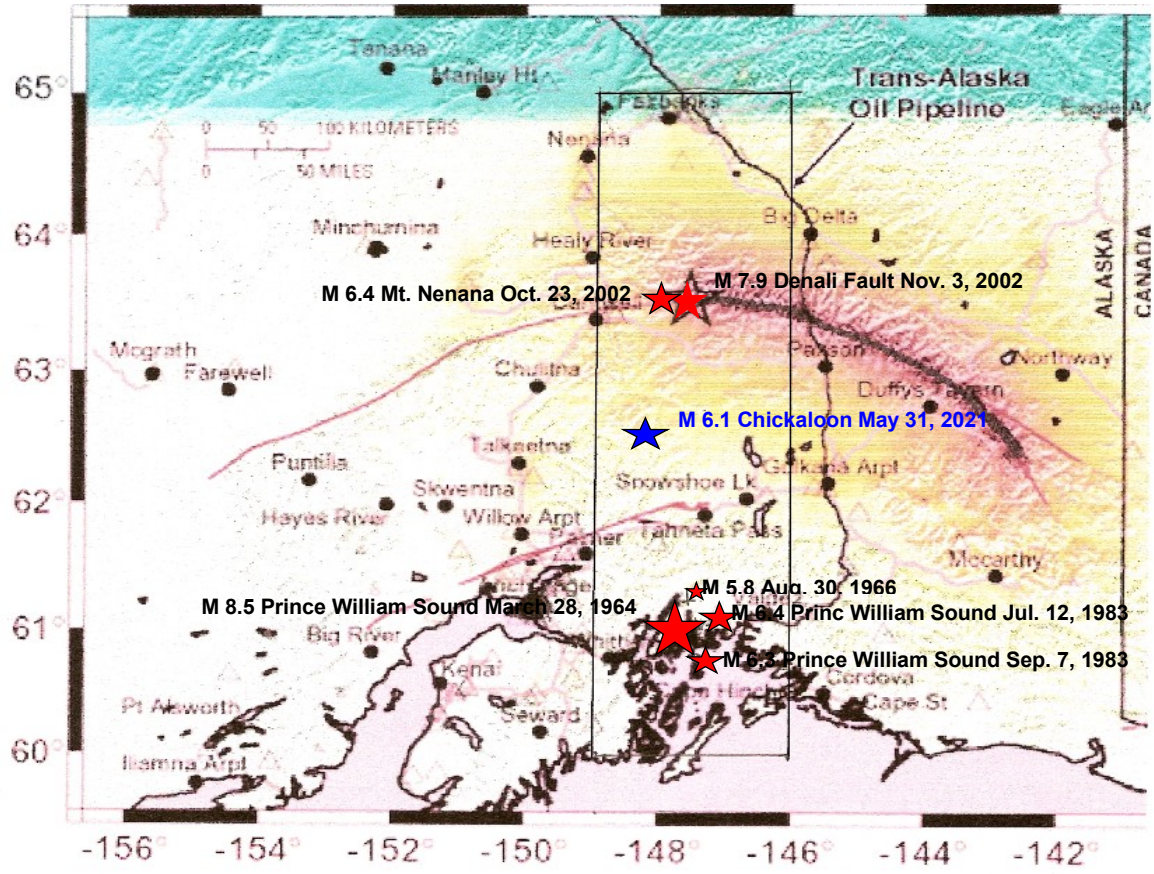

Figure 3. Investigated area is situated in narrow 3º belt in borders 146º-143ºW and 60º-65ºN covering area from Denali Fault to Prince William Sound.

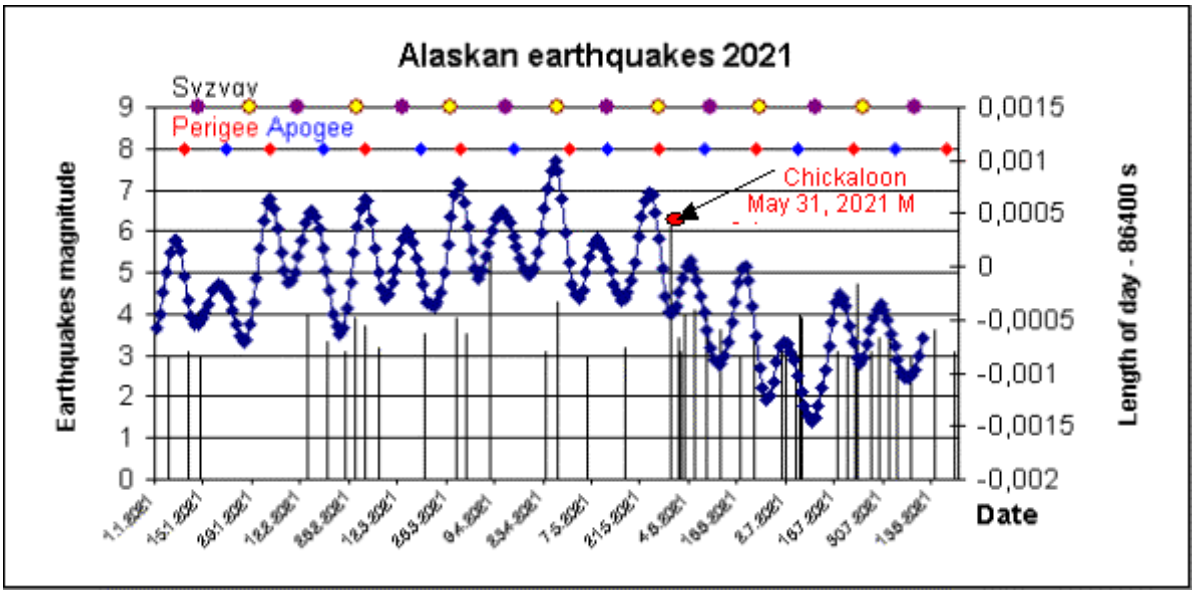

Figure 4 shows exact position of earthquake Chickaloon May 31, 2021 M 6.1 on LOD minimum, what confirms maximum swing of north-south tidal variation and maximum declination during Moon's orbital movement. Aftershocks mostly do not exceed 4th magnitude.

Fig. 5 of earthquake on Denali Fault November 3, 2002 shows triggering by resonance effect with 5 consequent strokes on LOD maximums, corresponding action of tidal friction directing westward and extending by this way the 1983-2002 period.
Fig. 6 earthquake Prince William Sound July 12, 1983 M 6.4 correlates exactly with LOD minimum, which represents maximum tidal torque and immediate earthquake triggering. Owing to delayed earthquake Denali Fault 2002, period 1983 – 2002 is extended.
Fig. 7, great earthquake Prince William Sound March 26, 1964 correlates with LOD maximum and action of tidal friction. This earthquake preceded many LOD maximums reaching maximum values on graph. This resulted in sooner action triggering. Because earthquake 1983 was triggered immediately the period 1964 – 1983 is extended.
Earthquake 1964 has been triggered in Full Moon, earthquake 2002 in New Moon. Except of this, earthquake March 28, 1964 was triggered on LOD maximum and therefore Moon's declination is 0º and Sun close to vernal equinox has also declination 0º, tidal action of both bodies is maximum, premature earthquake triggering is obvious.

Earthquakes in subduction zone
According to theory (Ostrihansky 2021) subduction zone dropping down to mantle by gravity releases by this way free space for the movement of lithospheric plate driven by tides, accordingly triggering earthquakes in transform faults.
Fig. 8 shows large earthquakes over 6 magnitude for last tidal period 2002-2021.These earthquake form groups with increasing earthquakes ending by large earthquake over 7th magnitude. Situation of these earthquakes for last decade is given on Fig. 9. Interest is directed to earthquake Chignik 29.7.2021 M 8.2, the largest earthquake in last 50 years. Earthquake is situated in shelf area of Gulf of Alaska, on LOD maximum (not evident on Fig. 8) therefore subjected to tidal friction force. This force really could act because shelf position corresponds to beginning of subduction and earthquake is situated on fault with similar earthquakes Perryvill 27.7.2020 M 7.8 (Fig. 9) and close Perryvill 19.10.2020 M 7.6. It is very probable that earthquake Chignik 29.7.2021 has been triggered by long-term tidal cycle, in spite that is far from investigated area. On the contrary the earthquake Anchorage 30.11.2018 M 7.1, situated very close to investigated area (Fig. 9) is deeply situated in subduction zone (depth 46.7 km) and cannot be subjected to action of tidal force.

Conclusion
Strong tides trigger strong earthquakes and their repetitions can be used for earthquake prediction. Owing to shift of earthquakes repetitions, it is not suitable for calculations of torques to use direct declination for the time of earthquake, but to consider 5-year shift and to calculate declination for the year of shift. For example Moon declination for 31.5.2021 is –19.911º. More suitable is value of declination for

31.5.2026, which is –27.087º. This value is close to value of lunar standstill in April 2025. The reason is that plates are driven by two parameters north-south variations and westward tidal friction. The same situation is with ocean tides. Water uplift is observable not directly when Moon is on meridian, but about 6 hour later owing to many tidal constituents causing water uplift. There are many different origins of earthquakes in Alaska. First of all they are earthquakes in subduction zone, sometimes strong with many aftershocks, not dependent on tides, and small earthquakes triggered by westward movement of collision of American plate with firmly anchored in mantle subduction zone, evident on its eastern side.

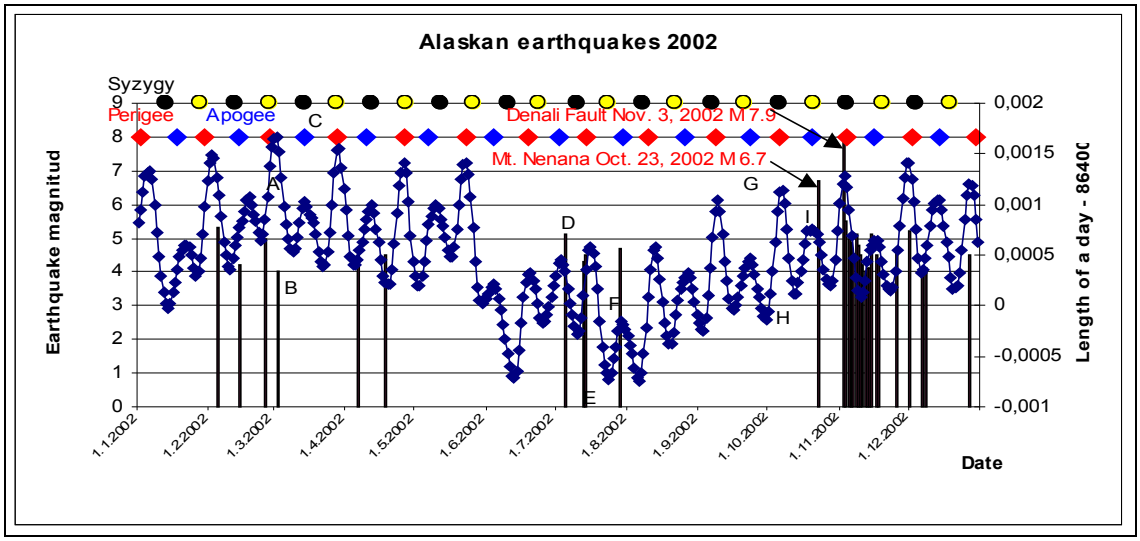

Figure 5. Earthquake Denali Fault Nov.3, 2002 is situated exactly on LOD maximum by consequent resonance by previous 5 LOD maximums starting with maximum on earthquake M 4.7, point F. Position on LOD maximum corresponds to 0º Moon's declination, confirming maximum effect of westward directing tidal friction force causing distinctive right lateral movement along Deanli Fault. Westward movement also supports Sun with Moon in New Moon position.

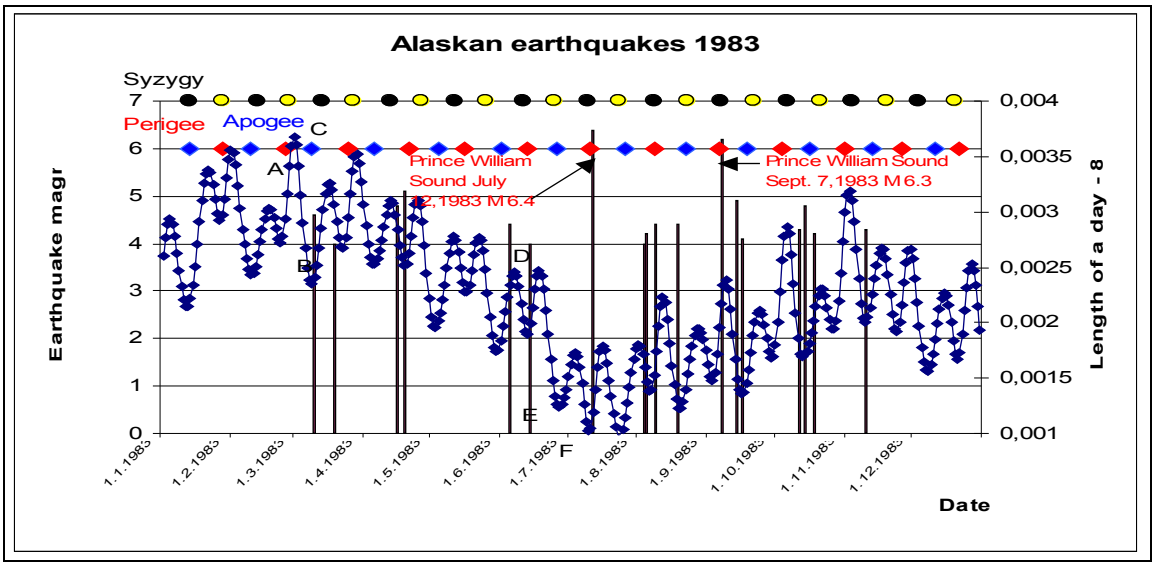

Figure 6. Position of earthquake Prince William Sound July 12, 1983 M 6.4 is situated on LOD minimum, therefore in similar position as earthquake Chickaloon M 6.1. Aftershocks except one earthquake do not exceed 5th magnitude and form groups in next LOD minimums.

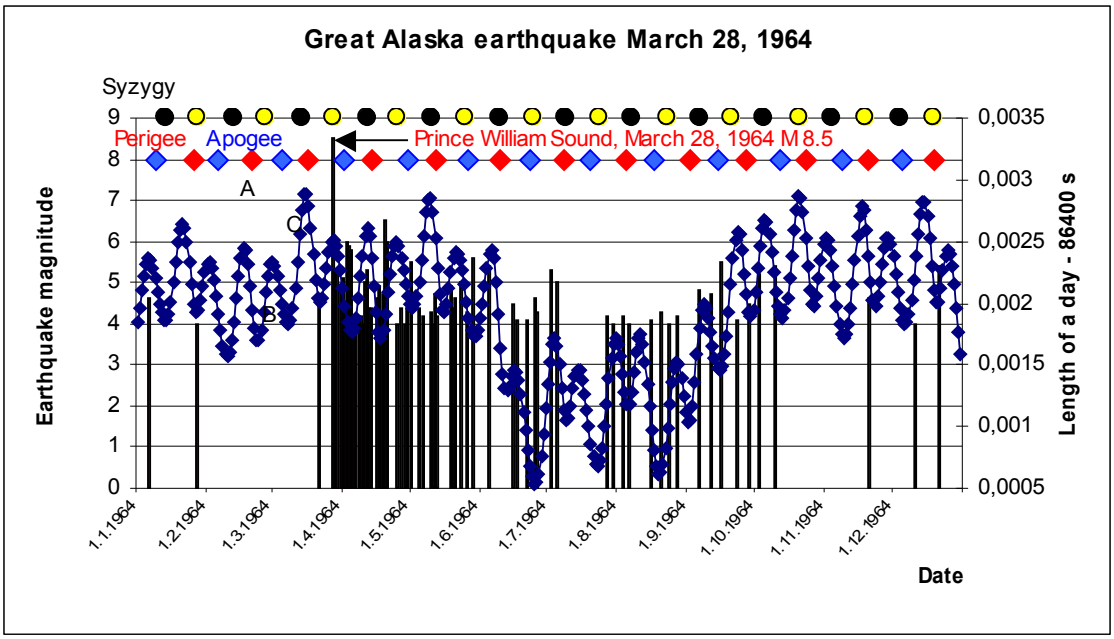

Figure 7. Great earthquake Prince William Sound March 26, 1964 M 8.5 (newly M 9.2) correlates with LOD maximum and with Full Moon. It has therefore Moon's declination 0º and also Sun's declination 0º because Sun is close to vernal equinox. Previous and following LOD minimums form torques, which swung the plate, facilitating the westward movement, forming ideal conditions for earthquake triggering. Aftershocks mostly do not exceed 6th magnitude**.**

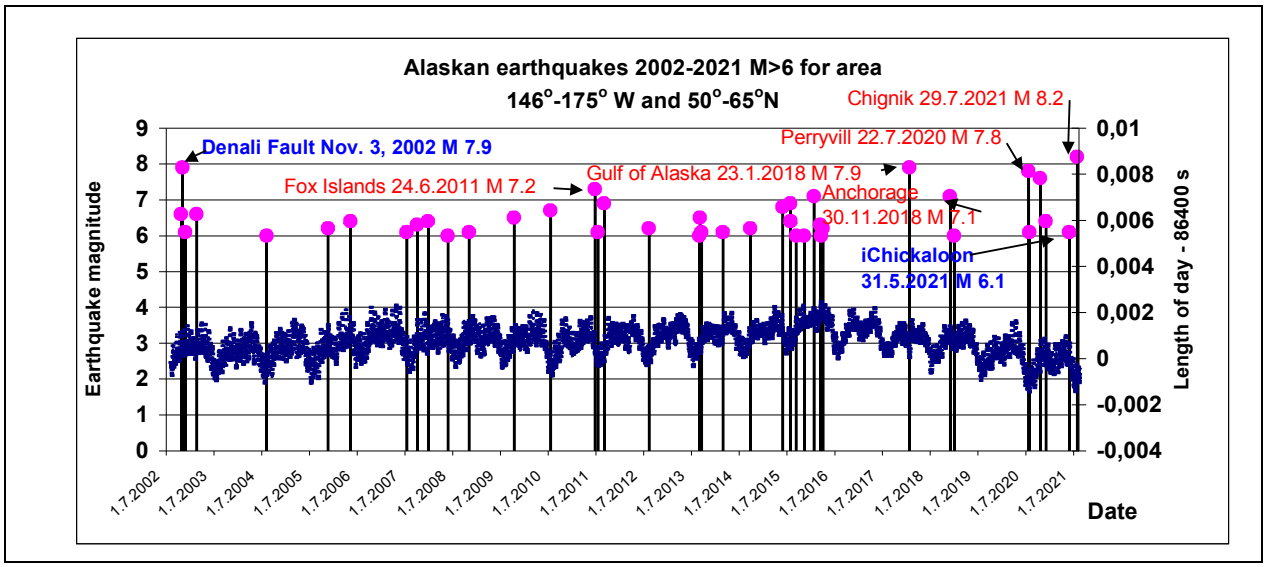

Figure 8 shows earthquakes over 6th magnitude in extended area, covering investigated area and also vast area of Aleutian subduction zone. Earthquakes in subduction zone do not correlate with tides and form rows of earthquakes with increasing magnitudes, earthquake Chignik 28.7.2021 M 8.2 is the last one. Possible correlation of Chignik earthquake with tides is explained in text.

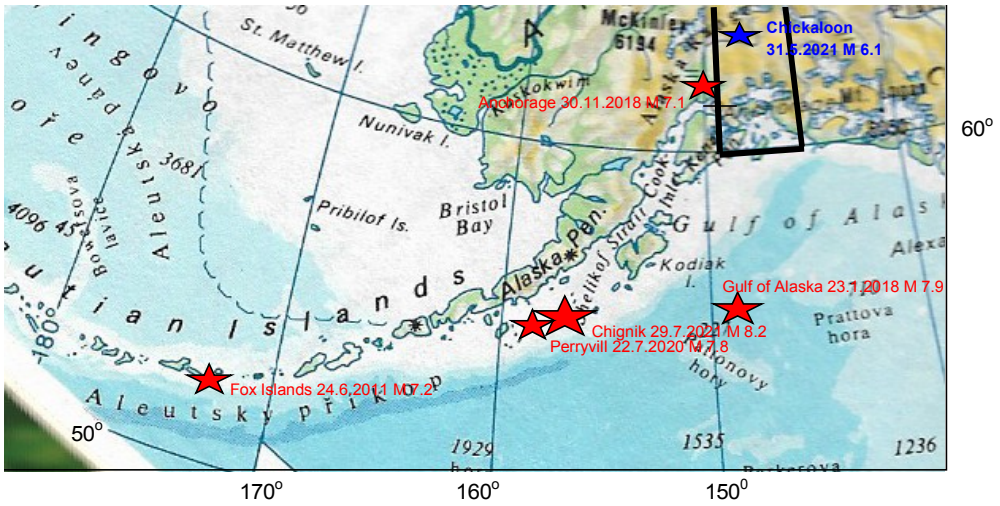

Figure 9 shows situation **of** marked earthquakes of Fig. 8 for the last decade and black contours mark investigated area. Earthquake Chignik 28.7.2021 M 8.2 is in shelf area of Gulf of Alaska and on eastern side of subduction zone. It id possible that this earthquake was subjected to the same tidal conditions as earthquakes in investigated area. Earthquake Anchorage 30.11.2018 M 7.1, close to investigated area is deeply in subduction zone and out of investigation.

References

Bostrom, R. C. 1971. Westward displacement of the lithosphere, Nature, **234**, 536–538.

Cochran, E.S., Vidale, T.E.and Tanaka, S. 2004. Earth tides can trigger shallow thrust fault earthquakes, *Science* **306,** 1164-1166 ().

Métivier, L., de Viron, O., Conrad, C. P., Renault, S., Diament, M., & Patau, G. 2009. Evidence of earthquake triggering by the solid earth tides. Earth Pl. Sci. Lett., **278**, 370–37.

Moore, G. W. 1973. Westward tidal drag as the driving force of plate tectonics, Geology, **1**, 99–100,

Ostřihanský, L. 1978. The radioactivity of the Earth's crust in the area of crystalline rocks in Bohemian Massif and its influence on the terrestrial heat flow. (in Czech with English abstract), Geophysical Institute of Czechoslovak Academy of Science, Prague.

Ostřihanský, L, 2017. The next strong earthquake in South-Central Alaska will be in 2021, Project Earthquake prediction. June 2017, doi**:** 10.13140/RG.2.2.18897.94569**.**

Ostřihanský, L, 2021 No mantle convection but efficient tidal forces move plates (Reworked), April 2021, available on ResearchGate.

Riguzzi F., Panza G., Varga P. and Doglioni C., 2009. Can Earth's rotation and tidal despinning drive plate tectonics? Tectonophysics, 484, 60-73.

Tanaka, S., 2012. Tidal triggering of earthquake prior to the 2011 Tohoku-Oki artquake (MW9.1). Geophys. Res. Lett., **39**, L00G26. doi: 10.1029/2012GL051179.

Van der Elst, N.J., Delorey, A.A., Shelly, D.R., Johnson, P.A., 2016. Fortnightly modulation of San Andreas tremor and low-frequency earthquakes. PNAS **113** (31), 8601-8605.