

4. Paper by Dr. Dong Choi and Mr. John L. Casey

New Madrid Seismic Zone, central USA: The great 1811-12 earthquakes, their relationship to solar cycles, and tectonic settings

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Abstract: The 1811-1812 New Madrid series of earthquakes were the largest in magnitude (estimated to be M8.0 or greater) in the continental North America in the history. The quakes occurred in the midst of Dalton Solar Minimum (1793-1830). Other major historic earthquakes in the same region also occurred during major solar minimums, or “solar hibernations.” From a tectonic viewpoint, the New Madrid Seismic Zone (NMSZ) is situated on the axis of the N-S American Geanticline or Super Anticline which is Archean in origin. It has been subject to repeated magmatic and tectonic activities in Proterozoic and Phanerozoic – the Caribbean dome (now oceanized to form the Caribbean Sea and the Gulf of Mexico) has been the site for rising thermal energy from the outer core since the Mesozoic. Energy transmigrates northward along the anticlinal axis (or surge channel) and is trapped at the embayment bounded by less permeable Precambrian-Paleozoic basement highs in the north of the New Madrid area. The arrival of a major, prolonged solar low period or “hibernation” in the coming 30 years, which are considered comparable to the Dalton or even Maunder Minimum (1645-1715), increases the likelihood of repeating the 1811-12 class seismic events. Heightened awareness, monitoring of precursory signals, and disaster mitigation planning are required.

Keywords: *1811-12 New Madrid Earthquakes, Dalton Minimum, solar hibernation, N-S American Super Anticline, surge channel, seismic energy transmigration, earthquake-solar cycle anti-correlation*

Introduction

The New Madrid area, mid-Mississippi River, central United State, was rocked by a spate of powerful earthquakes from 1811 to 1812 (**Fig. 1**). According to the USGS records, there were three main shocks, M7.5, 7.3 and 7.5, on 16 December 1811, 23 January 1812, and 7 February 1812, respectively, with a major aftershock M7.0 on the first day (<http://earthquake.usgs.gov/earthquakes/states/events/1811-1812.php>). Other researchers, such as Nuttli (1987) listed six M7.0+ quakes that include two M8.0+ earthquakes. Of them, two largest quakes were considered the greatest earthquakes in continental North America (Johnston and Schweig, 1996).

The sequence of the great earthquakes in the NMSZ has a unique attribute – it occurred in the middle of a major solar low period, Dalton Minimum, 1793 to 1830 (**Fig. 2**). This prompted the authors to study seismic history of the NMSZ and their relation to solar cycles, together with geological settings of the surrounding region. The rationales of this study are, 1) the arrival of a prolonged solar low period as advocated by Casey (2008, 2012 and 2014), and 2) the well-established reversed correlation between the solar activity cycle and earthquake energy (Choi and Maslov, 2010), and 3) new interpretation of geological structure of the region and seismic energy transmigration mechanism in the Caribbean-Gulf of Mexico-Mississippi River (Choi, 2013; Choi, 2014; Choi et al., 2014).

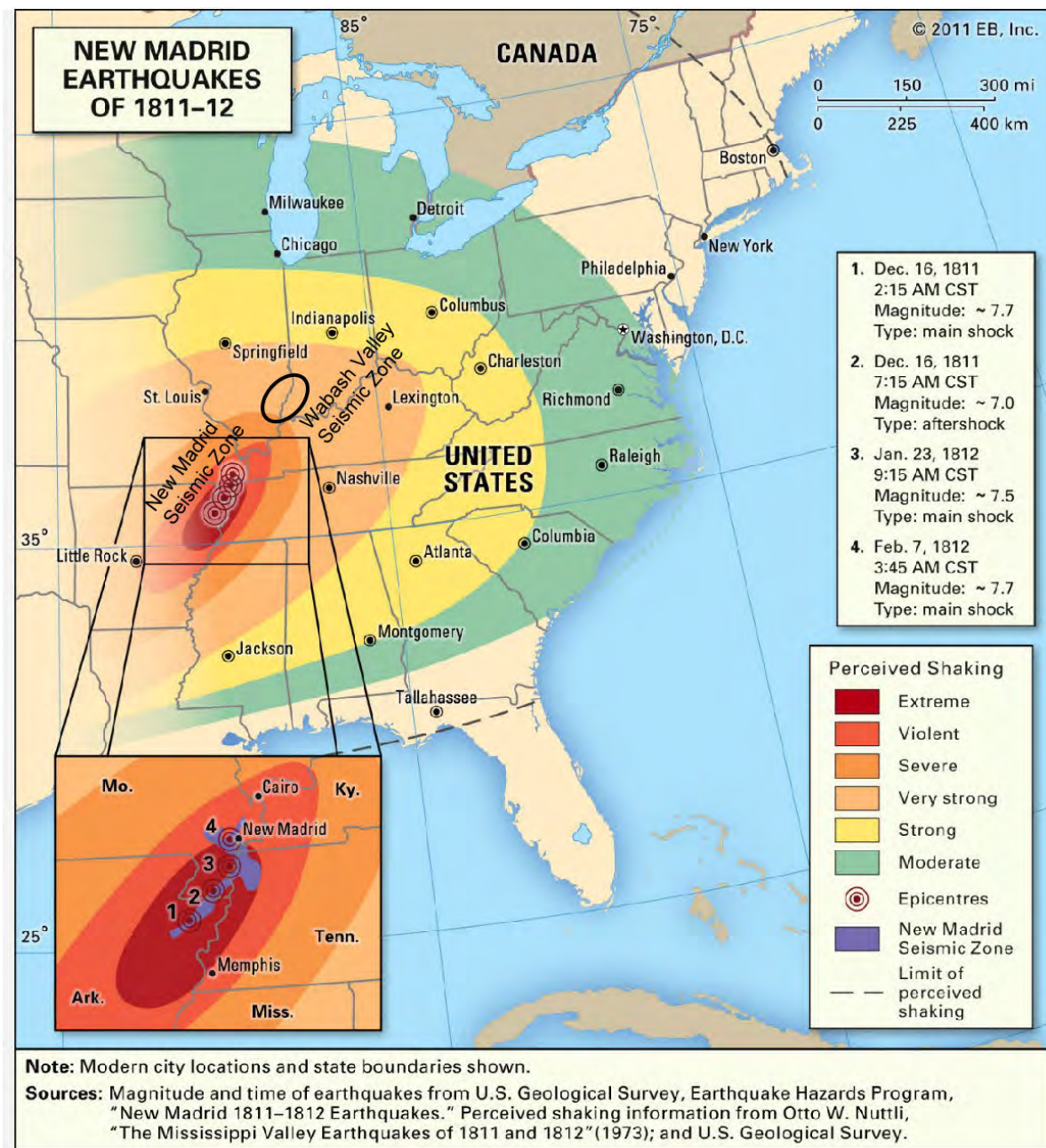


Fig. 1. Map of the New Madrid earthquakes of 1811-12. Base map cited from Encyclopedia Britannica, Inc. (<http://www.britannica.com/EBchecked/topic/1421133/New-Madrid-earthquakes-of-1811-12>). Wabash Valley Seismic Zone is added.

Seismic activity in the NMSZ and solar cycles

Historic records show that the New Madrid region has been subject to repeated seismic activities. Based on artifacts found buried by sand blow deposits and from carbon-14 studies, previous large earthquakes like those of 1811-1812 appear to have happened around 4800BC, 3500BC, 2350 BC, AD300, AD900 and AD1450. In addition, the first known written record of an earthquake felt in the New Madrid Seismic Zone occurred on Christmas Day of 1699. An M6.6 earthquake in 1895 has also been registered (Wikipedia, http://en.wikipedia.org/wiki/New_Madrid_Seismic_Zone).

Most of the years listed above belong to solar low periods (**Figs. 2 and 3**): The years 1811-1812 is in the midst of a major solar low period, Dalton Minimum. The year 1699 sits in another major solar low period, Maunder Minimum, 1645-1715. AD1450 corresponds to the lowering period of Spörer Minimum, and another one in 1895, centennial low cycle (1885-1915; Casey, 2008; **Fig. 2**).

Importantly, all major Earthquakes in the NMSZ since 1400 AD have occurred during these solar low points or solar hibernations.

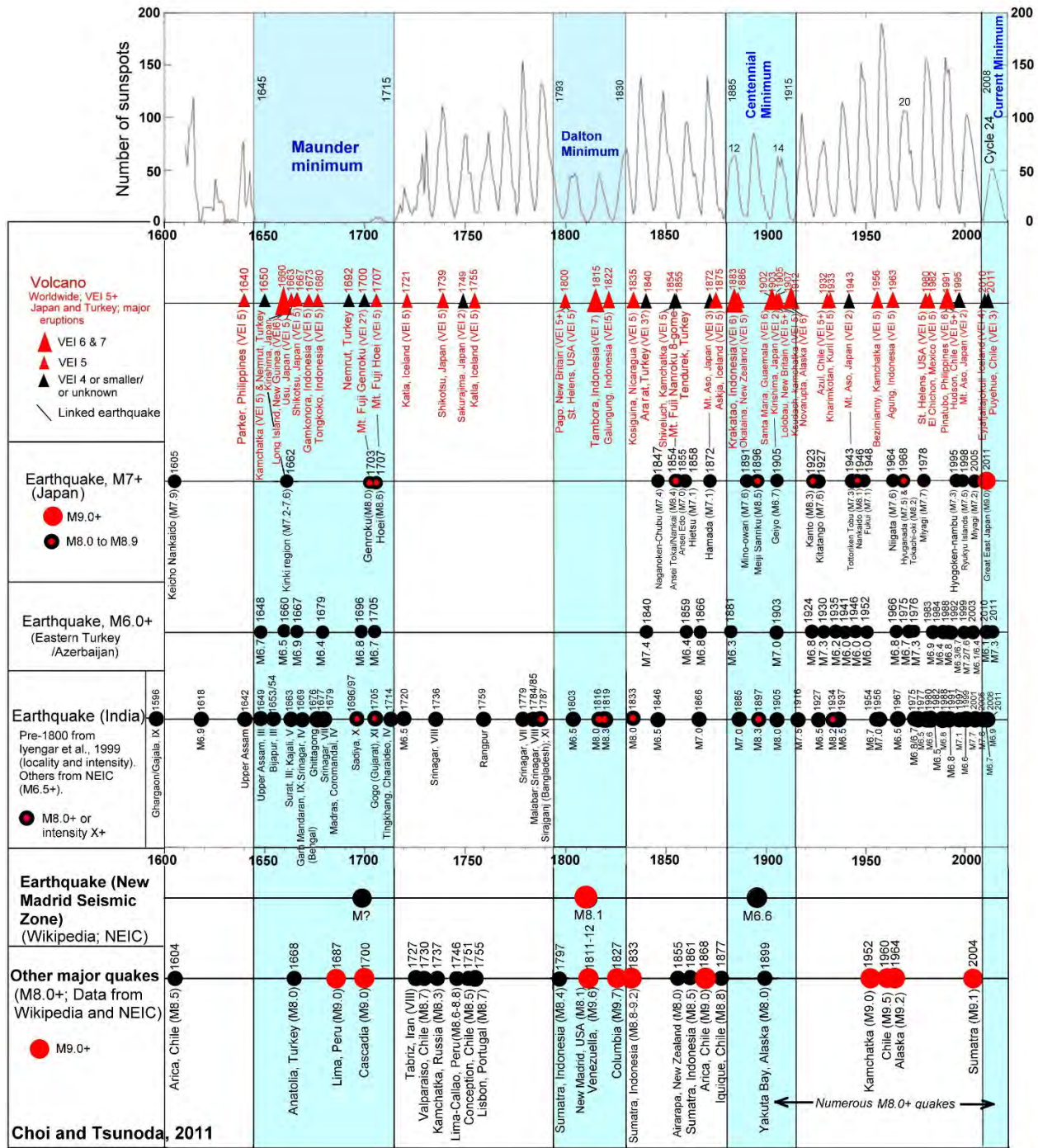


Fig. 2. Solar cycle and world volcanic/seismic activities. All of the NMSZ quakes occurred around the middle of the solar low periods. Cited from Choi and Tsunoda, 2011 and Choi, 2013b.

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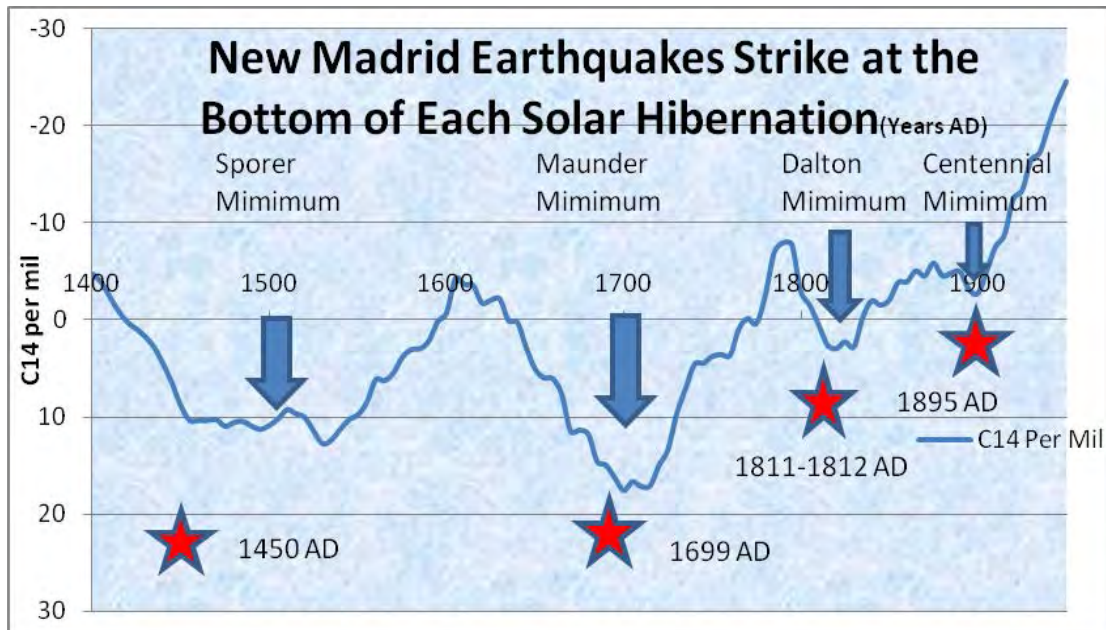


Fig. 3. History of New Madrid earthquakes compared to solar minimums or “solar hibernations” from 1400-1950 AD. Solar activity deduced from C¹⁴ proxy variation. The years of major New Madrid earthquakes are shown in red stars with dates. Source: Casey, Data: Reimar et al., INTCAL04.

The NMSZ quakes and solar cycles indicate their reversed correlation. The anti-correlation between solar cycles and seismic/volcanic activities has been well established by the senior author of this paper with co-workers (Fig. 4; Choi and Maslov, 2010; Choi and Tsunoda, 2011). Casey (2010) also noted that the catastrophic volcanic eruptions had taken place during the solar low periods.

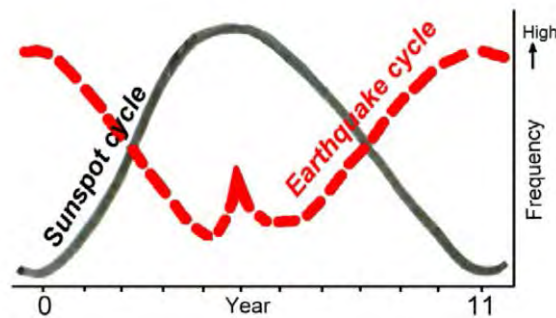


Fig. 4. Anti-correlation between the solar and earthquake cycles (Choi and Maslov, 2010).

The cause of this anti-correlation awaits further study. One of the feasible explanations was presented by Gregori (2002) who attributed to the Earth's core being a leaky capacitor or a battery; when solar activity is high, the Earth's core is charged, whereas when the Sun's activity is in low phase, the core in turn discharges energy.

Discussion

1) Geological structures responsible for the NMSZ earthquakes

The earthquakes occurred in the NMSZ come from the unique tectonic settings. It is strongly related to the global-scale geological structure; North-South American Geanticline or Super Anticline that runs from South America, via the Caribbean and Mississippi Valley, to the Canadian Shield (Choi, 2013; **Figs. 5 and 6**). It is a fundamental geological structure formed in the early stage of the Earth's formation – in Archean. There is another antipodal super anticline that extends from SW Pacific, via SE Asia and South China, to Siberia. These anticlinal structures have influenced the subsequent development of the Earth by repeated magmatic and tectonic activities throughout the Phanerozoic, especially since Mesozoic.

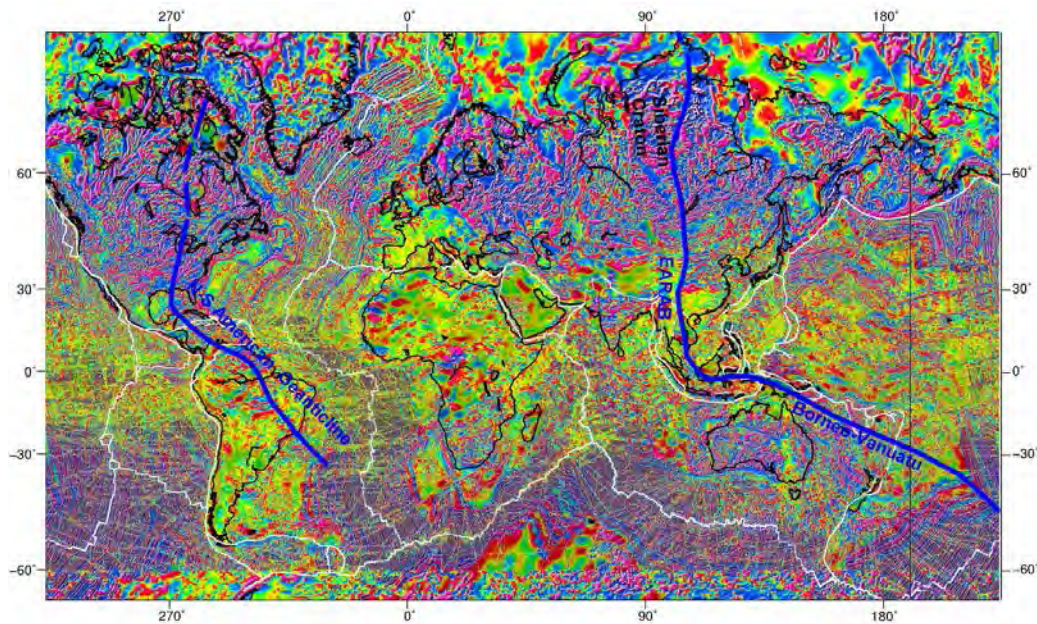


Fig. 5. Earth's fundamental structures; two antipodal super anticlines (Choi, 2013a). Note that the Caribbean Sea and the Mississippi Valley are situated on the axis of the anticline. Base map, World magnetic anomaly map, by Korhonen et al., 2007.

In his 2010 and 2014 papers, the senior author argued the origin of the Caribbean - Gulf of Mexico, which developed in the axial part of the anticline and formed the Caribbean dome; the crust in the site where energy rose from the outer core has been oceanized since Mesozoic. The initial basin formation however may go back to Paleozoic time (Pratch, 2008 and 2010). The axial area, being highly fractured and permeable, became a channel of energy flow, or surge channel (Meyerhoff et al., 1996). The thermal seismic energy, derived from the outer core through the Caribbean dome and transmigrated along the surge channel developed under the Mississippi Valley, is responsible for the NMSZ earthquakes (**Fig. 6**). This assertion is supported by the fact that, along the Pacific coast of Central America, the seismo-volcanic energy which was originated from the deep Caribbean was found to transmigrate northward during the solar low cycles but southward during the rising cycles (Choi, 2014). The energy from the outer core was stronger during the time of solar low phase, as evidenced by the well-established solar cycle-earthquake anti-correlation (**Fig. 4**).

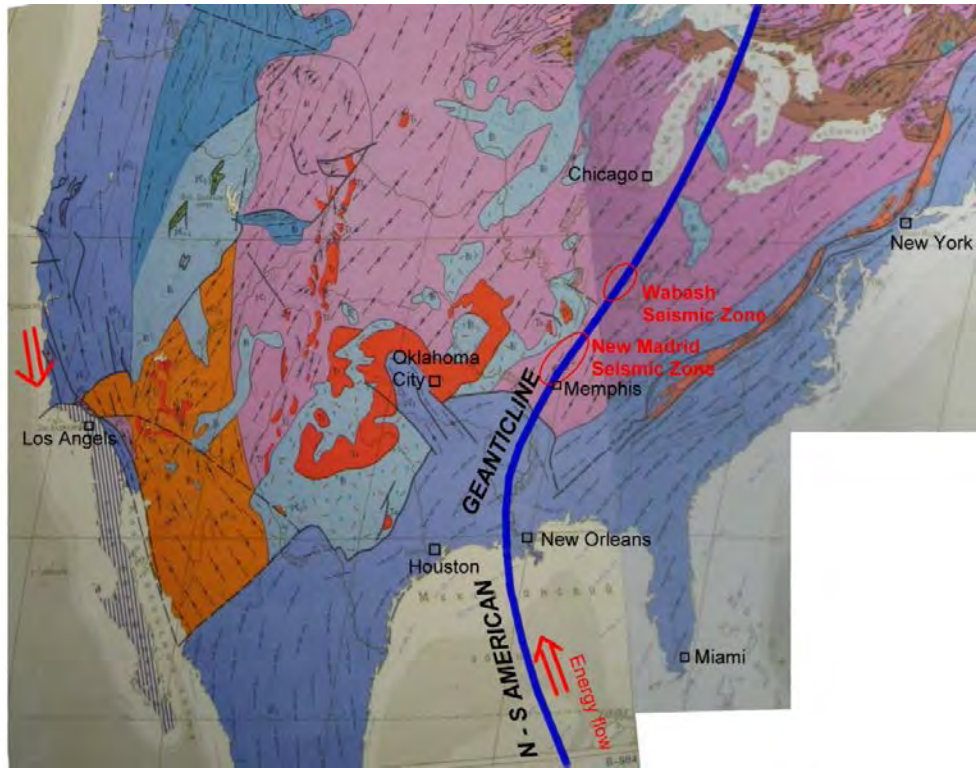


Fig. 6. N-S American Geanticline, the NMSZ and deep structure of the North America represented by Precambrian structures (Kosygin et al., 1970). Energy flow direction along the N-S American Geanticlinal axis from Choi (2014), and for California-Mexico from Choi et al. (2014). Note the prevailing NE-SW deep structural trends which seemingly continue into the Pacific Ocean.

A geological map, **Fig. 7**, well illustrates a Mesozoic embayment developed along the Mississippi Valley. The NMSZ area is the northern end of the Mesozoic basin that covers the present Gulf of Mexico and the Caribbean. The NMSZ region is surrounded by older, less permeable, Precambrian-Paleozoic rocks – which form a trap structure for thermal seismic energy in the form of liquid and gas. The trap structures were controlled by deep fault systems, which are NE-SW and NW-SE in direction (Johnson and Schweig, 1996).

3) Arrival of a major, prolonged, solar low period, or solar hibernation.

The correlation of major earthquakes and solar activity, while relatively recently discussed, is nonetheless one of the strongest in terms of climate change and geophysical associations. The initial paper (Casey, 2008) on the regular pattern of climate oscillations linked to solar activity using the Relational Cycle Theory (RC Theory) has demonstrated itself to be among the most successful in climate prediction underscoring the basic reliability of the theory and its associated seven elements of climate change. Subsequently (Casey, 2010) in a preliminary paper, proposed the connection between the RC Theory and major earthquakes and volcanic activity. Others noted above (Choi, Maslov, et al.), have also found the strong relationship between solar activity lows and increased seismic and volcanic activities.

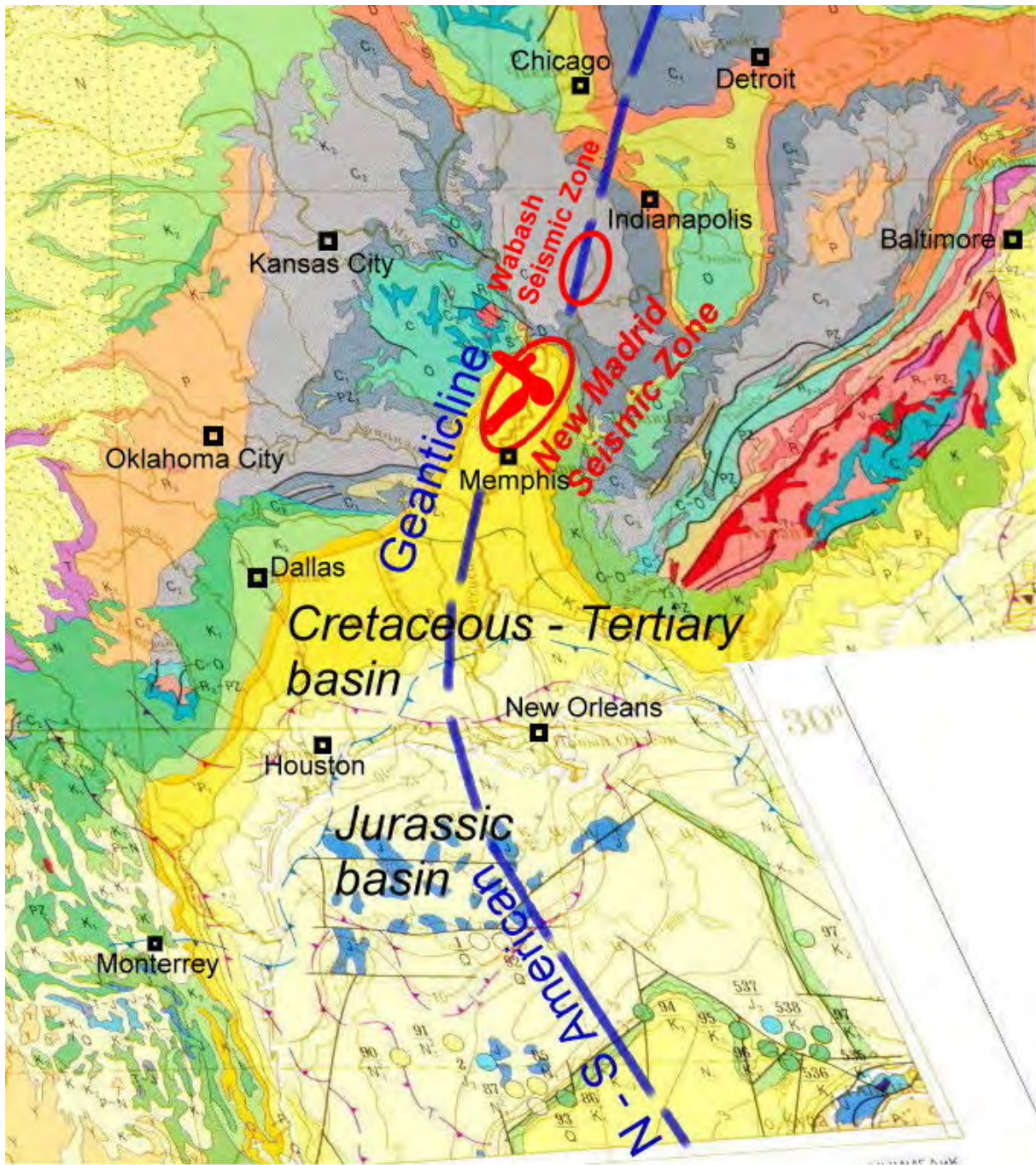


Fig. 7. Geologic map by Jatskevich et al. (2000) superimposed by tectonic elements and the NMSZ which is located at the northern end of the Mesozoic-Paleogene basin (labelled as K, K₁, K₂ and P).

Conclusions

This study revealed several important factual data regarding the strong earthquakes in the NMSZ and their relation to solar cycle. It also presented new interpretation of tectonic settings of the region. They are summarized as follows:

1. The NMSZ developed on the major Precambrian-origin geanticlinal axis where magmatic, thermal, and tectonic activities have been concentrated, particularly since Mesozoic when the Gulf of Mexico and the Caribbean have started to form. This activity is still continuing today.
2. The historic record clearly shows that large seismic events in the NMSZ have occurred during the Sun's inactive periods. The sequence of 1811-12 quakes is one of them.
3. In the light of the now confirmed start of a prolonged, solar hibernation for the coming 30 years or so, which are comparable to Dalton Minimum or worst case, a Maunder Minimum ("Little Ice Age"), a repeat of the 1811-12 earthquakes should be expected.
4. The window of highest risk for another major New Madrid zone earthquake is between 2017 and 2038.
5. Planning for a repeat of the 1811-1812 series of earthquakes that devastated the region back then should begin immediately. Considerations should include:
 - a. A US nationwide plan is required based on one or more M8.0+ earthquakes in the NMSZ on the assumption that substantial regional loss of life and massive infrastructure damage will take place on a scale never before witnessed in the USA.
 - b. This plan should include heightened levels of public education, monitoring of the seismic precursory signals, federal, state and local emergency management exercises and damage mitigation where practicable.
 - c. Planning should address the real possibility of complete loss of major ground and air

transportation nodes and routes including substantial long term damage to airport facilities and runways and interstate and city highway systems especially across the Mississippi River.

d. Planning should also include the assumption that major aftershocks will prevent meaningful rebuilding of permanent structures over several months to a year.

e. Should a repeat of a series of quakes take place similar to the 1811-1812 events or even a repeat of the 1895 M6.6 earthquake, the power grid in the central Mississippi region may be unavailable for essential needs of radio and TV communications, emergency management, search and rescue etc for several months to a half year or more.

f. In the case where there may be NMSZ nuclear facilities not designed to withstand a series of M7.5 to M8.0+ earthquakes, a new added risk may exist. All nuclear facilities must be reviewed (if not already done so) to insure they and their back-up power systems for coolant systems etc., can withstand a worst case series of major quakes. Failure to do so could result in multiple instances of the March 11, 2011 Japanese, Fukushima nuclear reactor style catastrophes in the middle of the United States. This could directly affect the safety of all citizens east of the central Mississippi River subject to prevailing winds during the time of the year such a scenario might happen.

References

- Cahill, R.T., 2014. Solar flare five-day predictions from quantum detectors of dynamical space fractal flow turbulence: Gravitational wave diminution and Earth climate cooling. *Progress in Physics*, v. 10, Issue 4 (October), p. 236-242. (http://ptep-online.com/index_files/2014/PP-39-10.PDF).
- Casey, J.L., 2008. The existence of 'relational cycles' of solar activity on a multi-decadal to centennial scale, as significant models of climate change on Earth. *Space and Science Research Center, Research Report 1-2008 – The RC Theory*. p. 1-8. www.spaceandscience.net
- Casey, J.L., 2010. Correlation of solar activity minimums and large magnitude geophysical events. *Space and Science Research Center, Research Report 1-2010 (Preliminary)*, p. 1-5.

- Casey, J.L., 2012. Cold Sun. Trafford Publishing, 167p.
- Casey, J.L., 2014. Dark winter: How the Sun is causing a 30-year cold spell. Humanix Books. 164p. www.Amazon.com.
- Choi, D.R., 2010. The January 2010 Haiti seismic disaster viewed from the perspective of the energy transmigration concept and block tectonics. *NCGT Newsletter* (www.ncgt.org), v. 54, p. 36-44.
- Choi, D.R., 2013a. An Archean geanticline stretching from the South Pacific to Siberia. *NCGT Journal* (www.ncgt.org), v. 1, no. 3, p. 45-55.
- Choi, D.R., 2013b. Earthquake/volcanic activities and solar cycles. *The Global Climate Status Report*. Edition 3–2013, September, p. 10-19. Space and Science Research Corporation. Orlando.
- Choi, D.R., 2014. Seismo-volcanic energy propagation trends in the Central America and their relationship to solar cycles. *NCGT Journal*, v. 2, no. 1, p. 19-28.
- Choi, D.R. and Maslov, L., 2010. Earthquakes and solar activity cycles. *NCGT Newsletter*, no. 54, p. 36-44.
- Choi, D.R. and Tsunoda, F., 2011. Volcanic and seismic activities during the solar hibernation periods. *NCGT Newsletter*, no.61, p. 78-87.
- Choi, D.R., Tsunoda, F. and Maslov, L., 2014. Seismo-volcanic energy propagation trends in the Aleutian Islands and North America. *NCGT Journal*, v. 2, no. 2, p. 13-22.
- Geogry, G.P., 2002. Galaxy-Sun-Earth relations. *Beiträge zur Geoschichte der Geophysik und Kosmischen Physik*, Band 3, Heft 4, 471p.
- Iyengar, R.N., Sharma, D. and Siddiqui, J.M., 1999. Earthquake history of India in Medieval times. *Indian Journal of History of Science*, v. 34, no. 3, p. 181-237.
- Jatskevich, B.A. (ed.), 2000. Geological Map of the World. 1:15,000,000 scale. Ministry of Natural Resources of Russian Federation, RAS.
- Johnston, A.C. and Schweig, E.S., 1996. The enigma of the New Madrid Earthquakes of 1811-1812. *Anna. Rev. Planet. Sci.*, v. 24, p. 339-384.
- Korhonen, J.V., Fairhead, J.D., Hamoudi, M, Hemant, K., Lesur, V., Manda, M., Maus, S., Purucker, M. Ravat, D., Sazonova, T. and Thebault, E., 2007. Magnetic anomaly map of the World (and associated DVD), Scale, 1:50,000,000, 1st edition, Commission for the Geological Map of the World, Paris, France.
- Kosygin, Yu.A., Basharin, A.K., Berzin, N.A., Borukayev, Ch.B., Matveyevskaya, A.L., Parfyonov, L.M., Chikov, B.M. and Schmidt, E.K., 1970. Structural and Material Complexes of the World. 1:15,000,000 scale. Compiled by Laboratory of Geotectonics, Institute of Geology and Geophysics, Siberian Branch, Academy of Science of USSR.
- Meyerhoff, A.A., Taner, I., Morris, A.E.L., Agocs, W.B., Kamen-Kaye, M., Bhat, M.I., Smoot, N.C., Choi, D.R. and Meyerhoff-Hull, D. (ed.), 1996. *Surge tectonics: a new hypothesis of global geodynamics*. Kluwer Academic Publishers, 323p.
- Nuttli, O.W., 1987. The effects of earthquakes in the central United States. *Rep. for Central US Earthq. Consort.* Memphis TN: Fed. Emerg. Manage. Agency, 33p.
- Pratsch, J.C., 2008. Letter to the Editor. *NCGT Newsletter*, no. 47, p. 4.
- Pratsch, J.C., 2010. Gulf of Mexico Basin – a collapsed Late Carbonifers mantle dome? *NCGT Newsletter*, no. 55, p. 74-76.