
Munich Personal RePEc Archive

9/56 Year Cycle: Californian Earthquakes

McMinn, David

March 2011

Online at https://mpra.ub.uni-muenchen.de/51663/
MPRA Paper No. 51663, posted 27 Nov 2013 06:07 UTC

David McMinn
Independent Scholar
mcminn56@yahoo.com
www.davidmcminn.com

David McMinn completed a BSc at the University of Melbourne in 1971 and subsequently worked as a mineral economist in ANZ Banking Group Ltd (a major Australian financial institution). Since leaving this position in 1982, he has conducted private research on cycles, with his main interests centering on Moon Sun cycles and the 9/56 year grid. These involved new innovative concepts in cycle studies. McMinn has published numerous papers and articles in the fields of technical analysis and seismology, as well as three books on market timing.

Original Paper
McMinn, David. 2011. 9/56 Year Cycle: Californian Earthquakes. New Concepts in Global Tectonics Newsletter. No 58. p 33-44. March.

9/56 YEAR CYCLE: CALIFORNIAN EARTHQUAKES

David McMINN

Abstract: The 9/56 year cycle was first established in the timing of US and Western European financial panics since 1760. This cycle was then assessed in patterns of major earthquakes in California - Nevada - Baja California. These important events tended to cluster within this 9/56 year grid, far more than could be expected by chance. Hawaiian quakes were also assessed and showed similarities with seismic episodes in south western North America. Furthermore, record seismic quakes appeared selectively within the 9/56 year cycle and included such important historical events as the 1700 Great Cascadia quake, the 1906 San Francisco quake and the 1980 Mt St Helens eruption, as well as the record quakes for Nevada, New Mexico, Arizona and Hawaii. Seasonality was another important factor as seismic events tended to occur around the same months of the year within various 9/56 configurations.

The 9/56 year seismic cycle was hypothesised to arise from tidal triggering by the Moon and Sun. What seemed most important were the ecliptical positions of the Sun, lunar ascending node and apogee. This implied that the angles between these factors and the spring equinox point may offer clues as to how this cycle actually functions. The siting of the Moon on the ecliptical circle should also have relevance, although no supportive evidence could be offered in the paper.

Key words*: earthquake, cycle, 56 year, California, Nevada*

Introduction

A 56 year cycle was first discovered in US economic history by Funk (1933). The concept was expanded upon by McMinn (1986, 1995, 2004), who established a 9/56 year cycle in the timing of major US and Western European financial panics over recent centuries. This was then extrapolated to seismic events by McMinn (1994, 2004). The 9/56 year cycle consists of a grid repeating the interval 56 years vertically (called sequences) and 9 years horizontally (called subcycles). Major seismic episodes in California - Nevada - Baja California were found to cluster within this grid, a situation that also applied to major Hawaiian quakes. Record earthquakes in south western North America were also considered in relation to the 9/56 year cycle.

The obvious question arises – what triggers the 9/56 year effect? The 9/56 year grid can be intimately linked with Moon Sun cycles and thus lunisolar tidal harmonics are hypothesised to trigger critical events within this pattern.

The plane of the Earth's orbit around the Sun is represented by the 360 degree ecliptical circle, with 00 E° being sited at the spring equinox point. The abbreviation E° was used to denote longitudinal degrees on the ecliptic and was equivalent to the angle made to the spring equinox point. The 56 year sequences have been numbered in accordance with McMinn (1995), with 1817, 1873, 1929 and 1985 being designated Sequence 01, 1818, 1874, 1930, 1986 as Sequence 02 and so forth. The full numbering was presented by

McMinn (Appendix 2, 2002). Year of best fit has been applied in the various tables in the text. **Appendix 6** gives a glossy of the terms used in this paper and is essential background reading.

9/56 Year Seismic Cycle

The US Geological Survey listed major quakes (mag => 6.9) occurring in California, Nevada and Baja California for the 1800-2000 period, with post 2000 events being inserted by the author (see **Appendix 1**). This compilation gave 31 events, of which 10 took place in the 12 months beginning April 15 of those years in **Table 1**. This compared with 2.5 that could have been expected by chance. **Table 1** comprised five 56 year sequences or about 9% of the complete 9/56 year grid. However, it contained:

* 36% of all major Californian earthquakes.
* 58% of all major Californian earthquakes taking place in October to December.

Crucially, four 56 year sequences in **Table 1** (Sqs 25, 34, 43 & 52) experienced many record events in south western North America.

Sq 25 - Record Baja California quake (Mexicali. mag 7.2. Apr 4, 2010).
Sq 25 – Equal 4th rank quake for Baja California (mag 6.9. Aug 3, 2010).
Sq 34 - Record northern Californian quake (San Francisco. mag 8.25. April 18, 1906).
Sq 34 - Record New Mexico quakes happened on July 16 and November 15 in 1906 (both mag 5.8).
Sq 43 - Record quake for Nevada (Pleasant Valley. mag 7.3. Oct 3, 1915).
Sq 43 - 2nd rank quake for Baja California (Volcano Lake. mag 7.1. Nov 21, 1915).
Sq 52 - Record quake for Hawaii (mag 7.9. Apr 2, 1868).
Sq 52 - Record US volcanic eruption (ex Alaska) (Mt St Helens, May 18, 1980).
Additional key records fell in another 9/56 year grid presented in **Appendix 2**.

Table 1
9/56 YEAR CYCLE: MAJOR QUAKES IN CALIFORNIA – NEVADA – BAJA CALIFORNIA 1800 – 2010 (mag => 6.9)
Year beginning April 15

Sq 25		**Sq 34**		**Sq 43**		**Sq 52**		**Sq 05**
				1803	+ 9	**1812 Dec 08 Dec 21**	+ 9	1821
1841	+ 9	1850	+ 9	1859	+ 9	**1868 Oct 21**	+ 9	1877
1897	+ 9	**1906 Apr 18**	+ 9	**1915 Oct 03 Nov 21**	+ 9	1924	+ 9	1933
1953	+ 9	1962	+ 9	1971	+ 9	**1980 Nov 08**	+ 9	**1989 Oct 18**

2009 Aug 03 2010 Apr 04								
Years in **bold** contained quakes (mag => 6.9) in the year beginning April 15.								

Moderate Californian Earthquakes

The US Geological Survey listed some 45 moderate earthquakes (=> 6.5 to =< 6.8 mag) for Californian – Nevada – Baja California during the period 1800 to 2010 (see **Appendix 3**). Of this figure, 17 occurred in an 18/56 year pattern (see **Table 2**), where as chance would dictate about 5.6.

Table 2
18/56 YEAR CYCLE: MODERATE QUAKES IN CALIFORNIA – NEVADA – BAJA CALIFORNIA
1800 – 2010 (mag 6.5 to 6.8)
Year beginning January 1

Sq 10	**Sq 28**	**Sq 46**	**Sq 08**	**Sq 26**	**Sq 44**	**Sq 06**
					1804	1822
		1806	1824	1842	1860 *	1878
1826	1844	1862	1880	1898 **	1916	1934 #**
1882	1900	1918 #*	1936	1954 #*****	1972	1990
1938	1956 *	1974	1992 ##**	2010 ##**		
1994 #*	2012					

The 56 year sequences are separated by an interval of 18 years.
# Denotes major earthquakes => 6.9 mag in this table.
* Denotes moderate earthquakes => 6.5 to =< 6.8 mag.
Source of Raw Data: US Geological Survey.

Major earthquakes (mag => 6.9) in south western North America happened preferentially in the 9/56 year pattern shown in **Table 1**. However, the lesser events mainly took place in an 18/56 year grid and in a different sector of the complete 9/56 year grid.

Seasonality

Sequences 43, 52 & 05 in **Table 1** contained 7 major quakes in the 2.7 months to December 21, whereas only 0.5 could have been expected by chance. Such seasonality also showed up in other 9/56 year patterns. In the following grid, four important Californian quakes occurred

in the 1.5 months to January 31, including the notable 1700 Great Cascadia and the 1857 Great Fort Tejon earthquakes.

Sq 52	Sq 05	Sq 14	Sq 23	Sq 32	Sq 41	Sq 50
1700 Jan 26						
1756	1765	1774	1783	1792	1801	1810
1812	1821	1830	1839	1848	**1857 Jan 09**	1866
1868	1877	1886	1895	1904	1913	**1922 Jan 31**
1924	**1933 1932 Dec 21**	1942	1951	1960	1969	1978
1980	1989	1998	2007	2016	2025	

In Sequences 12 & 21, two major Californian quakes happened in the month to June 15.

Sq 12		Sq 21
1884	+ 9	1893
1940 May 19	+ 9	1949
1996	+ 9	**2005 Jun 15**

The 1906 San Francisco earthquake and the 1980 Mt St Helens eruption took place in the month to May 18.

Sq 34		Sq 43		Sq 52
		1803	+ 9	1812
1850	+ 9	1859	+ 9	1868
1906 Apr 18	+ 9	1915	+ 9	1924
1962	+ 9	1971	+ 9	**1980 May 18**

2009 & 2010 Baja California Quakes

The August 3, 2009 Baja California earthquake (mag 6.9) showed seasonality, as three major earthquakes (mag => 6.9) occurred in the 1.3 months ended August 20.

Sq 07		Sq 16		Sq 25
1823	+ 9	1832	+ 9	1841
1879	+ 9	1888	+ 9	1897
1935	+ 9	1944	+ 9	1953

1991 **Jul 12** **Aug 17**	+ 9	2000	+ 9	**2009** **Aug 03**

The April 4, 2010 Baja Californian event (mag 7.2) took place in the following 18/56 year grid together with two other major April quakes (mag => 6.9).

Sq 46		**Sq 08**		**Sq 26**
1806	+ 18	1824	+ 18	1842
1862	+ 18	1880	+ 18	1898
1918 **Apr 21**	+ 18	1936	+ 18	1954
1974	+ 18	**1992** **Apr 25**	+ 18	**2010** **Apr 04**

Hawaiian Earthquakes

Hawaiian earthquakes often occurred within a similar section of the complete 9/56 year grid, as recorded for California in **Table 1**. The US Geological Survey listed 15 major quakes for the island of Hawaii (see **Appendix 4**). Of this figure, 8 took place in the 12 months ended August 31 of those years in **Table 3**, whereas 1.6 could have been expected by chance.

Table 3
9/56 YEAR CYCLE: HAWAIIAN QUAKES
Year ending August 31

Sq 34	**Sq 43**	**Sq 52**	**Sq 05**	**Sq 14**	**Sq 34**
		1868 **Apr 28** **Apr 02**	1877	1886	1895
1906	1915	1924	1933	1942 **1941** **Sep 25**	**1951** **Apr 22** **Aug 21**
1962 **Jun 27**	1971	1980	**1989** **Jun 25**	1998	2007 **2006** **Oct 15**

The 56 year sequences are each separated by an interval of 9 years.
Years in **bold** contained major Hawaiian earthquakes in the year ending August 31 of those years in the table.

Five Hawaiian quakes occurred in the 3 months ended June 27 of those years in **Table 3**, while coincidence would give about 0.4. The record quake for Hawaii (Apr 2, 1868) also fell in Sequence 52 and thus within the same 9/56 year sector as did most record earthquakes in south western North America (Sqs 25, 34, 43 & 52).

Discussion

To the author's knowledge, the timing of solar and lunar eclipses cannot be correlated with the timing of earthquakes. However, eclipse cycles are vitally important, because they give the repeating angles between Moon-Sun factors that determine the tidal forces on the Earth's surface. Importantly, tidal triggering is the hypothetical mechanism for activating major earthquakes within the 9/56 year grid.

Every 223 synodic months (one 18.0 year Saros), very similar angles repeat between the Moon, Sun, ascending node and apogee, while the Earth - Moon distance will be the same. These angles will also recur in similar ecliptical positions - plus about 11 degrees anticlockwise on the ecliptic every 223 synodic months (see **Table 4**). This repetition of angles is a property of the 223 synodic month interval that is separate from eclipse events.

223 synodic months divided by two gives the Half Saros of 111.5 synodic months. Every 9.0 tropical years, the Moon repeats the same angle to the ascending node, with the Sun 180 degrees on the opposite side of the angular circle. The apogee - Sun angle is similar, while the Moon – apogee angle changes in multiples of 60 degrees.

Every 1385 synodic months (or one 112 year eclipse cycle), the ecliptical positions of the Moon, Sun and ascending node repeat closely, giving rise to similar angles between these factors. Every 112 years, apogee will be sited plus about 240 degrees further anticlockwise on the ecliptic. Thus, the relative angles of apogee to the Moon, Sun and ascending node will increase by about 240 degrees.

On the same date every 56 years, the ascending node is located a further 3 E° clockwise on the ecliptical circle (eg: as on July 1: 1761 - AN at 48 E°; 1817 - 45 E°; 1873 - 42 E°; 1929 - 39 E°; 1985 - 36 E°) (see **Appendix 6**). This reflects a close alignment between the 18.6 year lunar nutation cycle and the solar year. Every 692.5 synodic months (or one 56.0 year cycle), the Sun forms the same angle to the ascending node with the Moon 180 degrees on the opposite side of the angular circle. The relative angles of apogee to the Moon, Sun and ascending node change in multiples of 60 degrees.

The 9/56 year cycle arises because the intervals of 111.5 and 692.5 synodic months give the angles of 0 and 180 degrees between the Moon, Sun and ascending node that recur very closely. Angles involving apogee repeat in multiples of about 60 degrees.

111.5 synodic months interval is equivalent to the 18.0 year Saros divided by two, while 692.5 synodic months is derived by dividing the 112 year eclipse cycle by two (see **Appendix 6**). Both the 18 year Saros and the 112 year cycle were listed by Robert van Gent in his extensive coverage of key Moon-Sun eclipse cycles.

The importance of 0, 60, 120 and 180 degree angles in these cycles probably involve the 1st, 2nd, 3rd and 6th harmonics.

Table 4
9/56 YEAR ECLIPSE CYCLES AND THE ECLIPTICAL POSITION OF MOON-SUN FACTORS

Date	Phase	Moon E°	Sun E°	LAN E°	Apo E°
223 Synodic Month Interval (One Saros)					
Nov 16, 1906	NM	233	233	126	074
Nov 26, 1924	NM	244	244	138	087
Dec 08, 1942	NM	255	255	149	101
Dec 18, 1960	NM	267	267	160	115
111.5 Synodic Month Interval (One Half Saros)					
Nov 16, 1906	NM	233	233	126	074
Nov 21, 1915	FM	058	238	312	081
Nov 26, 1924	NM	244	244	138	087
Dec 01, 1933	FM	069	249	323	095
Dec 08, 1942	NM	255	255	149	101
Dec 13, 1951	FM	081	261	334	108
Dec 18, 1960	NM	267	267	160	115
1385 Synodic Month Interval (One 112 Year cycle)					
Nov 29, 1682	NM	248	248	138	321
Nov 22, 1794	NM	241	241	132	198
Nov 16, 1906	NM	233	233	126	074
Nov 07, 2018	NM	225	225	120	310
692.5 Synodic Month Interval (One 56 Year cycle)					
Nov 29, 1682	NM	248	248	138	321
Nov 25, 1738	FM	064	244	135	079
Nov 22, 1794	NM	241	241	132	198
Nov 19, 1850	FM	057	237	129	316
Nov 16, 1906	NM	233	233	126	074
Nov 11, 1962	FM	049	229	123	192
Nov 07, 2018	NM	225	225	120	310

This table was presented to provide an example of how the Half Saros and 56 year cycle function in relation to ecliptical positions of the Moon, the Sun, ascending node and apogee.
Abbreviations: LAN Lunar Ascending Node. NM New Moon. FM Full Moon

Lunar Ascending Node Any events falling with significance in a 9/56 year pattern will always have the ascending node sited in two sectors approximately opposite in the ecliptical circle. For example, all 10 Californian earthquakes in **Table 1** occurred with the lunar ascending node in two narrow segments of the ecliptical circle:

* 285 – 325 E^{o} - a 40 degree segment.
* 135 – 145 E^{o} - a 10 degree segment.

Events in an 18/56 year grid will have the ascending node in the same ecliptical sector. All 17 moderate events in the 18/56 year grid (see **Table 2**) happened with the ascending node located between 250 and 320 E^o, a 70 degree ecliptical segment. No exceptions arose for either pattern, a factor very unlikely to occur by chance.

Apogee. Major earthquakes in California (see **Table 1**) and Hawaii (see **Table 3**) occurred with apogee sited in one of three ecliptical sectors: 050 – 095 E^o (7 events), 175 – 210 E^o (6) and 290 – 335 E^o (5) with no exceptions. Any phenomena occurring preferentially in a 9/56 pattern will have apogee grouped into three segments 120 degrees apart on the ecliptical circle.

Apogee and the lunar nodes are strongly associated with Moon-Sun tidal effects and these forces may help explain why Californian and Hawaiian earthquakes fall within 9/56 and 18/56 year patterns.

Aphelion – Perihelion. In a heavenly bodies' orbit around the Sun, aphelion is the point where its distance to the Sun is greatest, while perihelion gives the least distance. The Earth is at aphelion on about July 4 and at perihelion on about January 4. On the latter date, Sun's tidal effect would be strongest and this may have relevance to the timing of October to January Californian earthquakes in **Table 1**. No evidence can be offered to support this conjecture.

Conclusions

Major earthquakes (mag => 6.9) in California – Nevada – Baja California fell preferentially within the 9/56 year pattern as shown in **Table 1**. This particularly applied to events in the 2.7 months ended December 21. Four 56 year sequences (Sqs 25, 34, 43 & 52) also contained many record quakes in south western North America. Strangely, the major earthquakes (mag => 6.9) tended to group within one sector of the complete 9/56 year grid, where as moderate earthquakes happened in an 18/56 year grid (see **Table 2**) and in a different sector of the 9/56 year grid. It was assumed that both major and moderate quakes would occur in the same 9/56 year configuration, but this was not observed. Interestingly, Californian and Hawaiian earthquakes often took place within a similar sector of the complete 9/56 year grid – Sequences 34, 43, 52 & 05 in **Table 1** for Californian quakes also appeared in **Table 3** for Hawaiian quakes.

Any events clustering in a 9/56 year configuration will always have the lunar ascending node in two narrow segments approximately opposite in the ecliptical circle. For events in an 18/56 year grid, the ascending node will always be located within one segment of the ecliptic. Events occurring around the same time of year and in the same 9/56 year grid will always have the apogee point in restricted ecliptical segments 120 degrees apart. Seasonality was found to be relevant, as seismic events often happened around the same months within 9/56 patterns. Overall, the 9/56 year seismic cycle is speculated to arise from the varying angles between the Sun, lunar ascending node, apogee and the spring equinox point. The Moon should also have significance, although no supportive evidence was presented in the paper. Other factors may be important, such as diurnal cycles, the horizontal plane, perihelion and so forth, but this remains conjectural.

The findings strongly suggest that Moon-Sun tidal triggering activated major earthquakes, causing them to happen within 9/56 year patterns. It implies that the Moon-Sun effect in seismology may be much stronger than previously considered possible. How these forces actually functioned remained the great unknown. Hopefully this paper offers some insights that will assist the design of much needed follow up research. If the Moon-Sun mathematics can ever be deciphered, accurate predictions could be given for windows when major quakes were most likely to occur, a breakthrough that could potentially save many lives.

Acknowledgements
The author wishes to thank the editor Dong Choi and the reviewers for their many helpful suggestions during the revision of the original manuscript. Their input was most appreciated.

References

Funk, J.M., 1932. *The 56 Year Cycle in American Business Activity.* Ottawa, IL.
McMinn, D., 1986. *The 56 Year Cycles & Financial Crises.* 15th Conference of Economists. The Economics Society of Australia. Monash University, Melbourne. 18p. Aug 25-29.
McMinn, D., 1994. *Mob Psychology & The Number 56*. The Australian Technical Analysts Association Newsletter, p 28. March.
McMinn, D., 1995. *Financial Crises & The 56 Year Cycle*. Twin Palms Publishing.
McMinn, D., 2004. *Market Timing By The Number 56*. Twin Palms Publishing.
McMinn, D., 2006. *Market Timing By The Moon and The Sun*. Twin Palms Publishing.
McMinn, D., 2002. *9/56Year Cycle: Financial Crises*.
www.davidmcminn.com/pages/fcnum56.htm
US Geological Survey. *Californian Earthquake History: 1769 to Present.*
http://earthquake.usgs.gov/regional/sca/ca_eqs.php
US Geological Survey. http://hvo.wr.usgs.gov/earthquakes/destruct
van Gent, R., *A Catalogue of Eclipse Cycles.*
www.phys.uu.nl/~vgent/calendar/eclipsecycles.htm

Appendix 1
MAJOR EARTHQUAKES IN CALIFORNIA - NEVADA - BAJA CALIFORNIA 1800 – 2010 (mag => 6.9)

Year	Mth	Dy	Mag	Location
1812	**12**	**08**	**7.0**	**Wrightwood**
1812	**12**	**21**	**7.0**	**Santa Barbara Channel**
1838	06	00	7.0	San Francisco Peninsula
1857	01	09	8.25	Great Tejon earthquake
1868	**10**	**21**	**7.0**	**Hayward Fault**
1872	03	26	7.6	Owens Valley
1892	02	24	7.0	Laguna Salada, BC
1899	04	16	7.0	West of Eureka
1906	**04**	**18**	**8.25**	**Great San Francisco quake**
1915	**10**	**03**	**7.3**	**Pleasant Valley, Nevada**

1915	**11**	**21**	**7.1**	**Volcano Lake, BC**
1918	04	21	6.9	San Jacinto
1922	01	31	7.3	West of Eureka
1923	01	22	7.2	Cape Mendocino
1927	11	04	7.3	South West of Lompoc
1932	12	21	7.2	Cedar Mountain, Nevada
1934	12	31	7.0	Colorado River
1940	05	19	7.1	Imperial Valley
1952	07	26	7.7	Kern County
1954	12	16	7.1	Fairview Peak, Nevada
1980	**11**	**08**	**7.2**	**West of Eureka**
1989	**10**	**18**	**7.1**	**Loma Prieta**
1991	08	17	7.1	West of Crescent City
1992	04	25	7.2	Cape Mendocino
1992	06	28	7.3	Landers
1994	09	01	6.9	Mendocino Fracture Zone
1999	10	16	7.2	Hector Mine
2005	06	15	7.2	Offshore Northern California
2009	**08**	**03**	**6.9**	**Baja California**
2010	**04**	**04**	**7.2**	**Mexicali, Baja California**
2010	10	22	6.9	Baja California

(a) Includes quakes in California, Nevada and Baja California (mag => 6.9).
Events in **bold** occurred in the year beginning April 15 of those years in Table 1.
Main Source: US Geological Survey *Californian Earthquake History: 1769 to Present.* http://earthquake.usgs.gov/regional/sca/ca_eqs.php

Appendix 2

RECORD QUAKES IN SOUTH WESTERN NORTH AMERICA

Table 1 in the main text contained numerous records for south western North America. Many additional events occurred in the 9/56 year grid as presented in **Table A**. These two grids comprise 29% of the complete 9/56 year grid, yet they contained all the record quakes for California, Nevada, Arizona, New Mexico, Baja California, Sonora and Hawaii.
Sq 16 – Record quake for the Mexican state of Sonora (south of Arizona) (mag 7.5. May 3, 1887).
Sq 25 – 2nd rank quake for southern California (Kern County. mag 7.7. Jul 26, 1952).
Sq 34 – Equal 1st rank for Arizona (Flagstaff. mag 6.2. Jan 25, 1906).
Sq 05 – 2nd rank quake for Nevada (Cedar Mountain. mag 7.2. Dec 21, 1932).
Sq 41 – Record quake for southern California (Fort Tejon. mag 8.25. Jan 9, 1857).
Sq 41 – Equal 1st rank quake for Arizona (Lockett Tanks. mag 6.2. Aug 18, 1912).
Sq 50 – Equal 2nd rank quake for northern California (west of Eureka. mag 7.3. Jan 31, 1922).

Sq 50 – 4th rank quake for Arizona (Freedonia. mag 5.5. Jul 21. 1959).
Sq 52 – Record quake for western USA (ex Alaska) (Great Cascadia quake. mag 9.0. Jan 26, 1700).

Table A Appendix 2
9/56 YEAR CYCLE: RECORD QUAKES IN SOUTH WESTERN NORTH AMERICA 1850–2010
9 months ending January 31

Sq 16	Sq 25	Sq 34	Sq 43	Sq 52	Sq 05	Sq 14	Sq 23	Sq 32	Sq 41	Sq 50
									1857 Jan09	1866
		1850	1859	1868	1877	1886	1895	1904	1913 **1912 Aug18**	**1922 Jan31**
1888 **1887 May03**	1897	**1906 Jan25**	1915	1924	1933 **1932 Dec21**	1942	1951	1960 **1959 Jul21**	1969	1978
1944	1953 **1952 Jul26**	1962	1971	1980	1989	1998	2007			
2000	2009									

Record quakes mentioned in this appendix have been highlighted in **bold**.

Appendix 3
MODERATE QUAKES IN CALIFORNIA, NEVADA & BAJA CALIFORNIA
1800 – 2010 (mag => 6.5 to =< 6.8)

Year	Mth	Day	Mag	Location
1800	11	22	6.5	San Diego region
1836	6	10	6.75	Hayward Valley
1852	11	29	6.5	Volcano Lake, BC
1860	**3**	**15**	**6.5**	**Carson City, Nevada region**
1865	10	8	6.5	S. Santa Cruz Mountains
1872	3	26	6.75	Owens Valley
1872	4	11	6.75	Owens Valley
1873	11	23	6.75	Crescent City
1887	6	3	6.5	Carson City, Neveda region
1890	2	9	6.5	San Jacinto or Elsinore fault
1892	4	19	6.5	Vacaville
1892	5	28	6.5	San Jacinto or Elsinore fault
1898	**3**	**31**	**6.5**	**Mare Island**
1898	**4**	**15**	**6.5**	**Mendocino**

1911	7	1	6.5	Calaveras fault
1903	1	24	6.6	
1910	8	5	6.6	W. of Crescent City
1915	12	31	6.5	W. of Eureka
1918	**7**	**15**	**6.5**	**W. of Eureka**
1934	**7**	**6**	**6.5**	**W. of Eureka**
1934	**12**	**30**	**6.5**	**Laguna Salada, BC**
1941	2	9	6.6	
1942	10	21	6.5	Fish Creek Mountains
1948	12	4	6.5	Desert Hot Springs
1954	**7**	**6**	**6.6**	
1954	**8**	**24**	**6.8**	**Stillwater, Nevada**
1954	**11**	**25**	**6.5**	
1954	**12**	**16**	**6.8**	**Dixie Valley, Nevada**
1954	**12**	**21**	**6.6**	**E. of Arcata**
1956	**2**	**9**	**6.8**	**San Miguel, BC**
1968	4	9	6.5	Borrego Mountain
1971	2	9	6.5	San Fernando
1979	10	15	6.5	Imperial Valley
1983	5	2	6.5	Coalinga
1984	9	10	6.7	
1987	11	24	6.6	Superstition Hills
1992	**4**	**26**	**6.5**	**Cape Mendocino**
1992	**4**	**26**	**6.6**	**Cape Mendocino**
1994	**1**	**17**	**6.7**	**Northridge**
1995	2	19	6.6	W. of Eureka
2003	12	22	6.6	San Simeon
2005	6	17	6.6	Offshore northern California
2006	1	4	6.5	Santa Rosalia BC
2010	**1**	**10**	**6.5**	**Offshore northern California**
2010	**10**	**21**	**6.5**	**La Paz BC**

(a) Includes quakes in California - Nevada - Baja California (mag => 6.5 to =< 6.8).
Events in **bold** occurred in the year beginning January 1 of those years in Table 2.
Main Source: US Geological Survey. *Californian Earthquake History: 1769 to Present.* http://earthquake.usgs.gov/regional/sca/ca_eqs.php

Appendix 4
MAJOR HAWAIIAN QUAKES: 1865-2007

Year	Mag	Region
Mar 28, 1868	**6.5-7.0**	**Mauna Loa south flank**

Apr 2, 1868	**7.5-8.1**	**Mauna Loa south flank**
Oct 5, 1929	6.5	Hualalai
Sept 25, 1941	**6.0**	**Kaoiki**
May 29, 1950	6.2	Mauna Loa southwest rift
Apr 22, 1951	**6.3**	**Kilauea**
Aug 21, 1951	**6.9**	**Kona**
May 23, 1952	6.0	Kona
Mar 30, 1954	6.5	Kilauea south flank
June 27, 1962	**6.1**	**Kaoiki**
Apr 26, 1973	6.2	Honomu
Nov 29, 1975	7.2	Kilauea south flank
Nov 16, 1983	6.6	Kaoiki
June 25, 1989	**6.1**	**Kilauea south flank**
Oct 15, 2006	**6.6**	**Offshore west side of the island**

Years in **bold** contained major Hawaiian earthquakes in the year ending August 31 of those years in Table 3.
Source of Raw Data: US Geological Survey.

Appendix 5
9 & 56 YEAR LUNISOLAR CYCLES

18.0 Year Saros		
Days	**Years**	**Lunisolar cycles**
6,574.36	18.00	18.0 Tropical Years
6,585.78	18.03	19.0 Nodical Years
6,585.32	18.03	223.0 Synodic Months (One Saros)
6,584.51	18.03	241.0 Tropical Months
6,585.35	18.03	242.0 Nodical Months
6,585.55	18.03	239.0 Apogee Months
9.0 Year Half Saros		
Days	**Years**	**Lunisolar Cycles**
3,287.18	9.00	9.0 Tropical Years
3,292.89	9.02	9.5 Nodical Years
3,292.66	9.02	111.5 Synodic Months (One Half Saros)
3,292.26	9.01	120.5 Tropical Months
3,292.68	9.02	121.0 Nodical Months
3,292.77	9.02	119.5 Apogee Months
112.0 Year Cycle		
Days	**Years**	**Lunisolar Cycles**
40,906.88	112.00	112.0 Tropical Years
40,901.16	111.98	118.0 Nodical Years
40,899.89	111.98	1385.0 Synodic Months (One 112 Year Cycle)
40,900.44	111.98	1497.0 Tropical Months
40.899.94	111.98	1503.0 Nodical Months

40,900.12	111.98	1484.33 Apogee Months
56.0 Year Cycle		
20,453.44	56.00	56.0 Tropical Years
20,450.58	55.99	59.0 Nodical Years
20,449.94	55.99	692.5 Synodic Months (One 56 Year Cycle)
20,450.23	55.99	748.5 Tropical Months
20,449.97	55.99	751.5 Nodical Months
20,450.06	55.99	742.17 Apogee Months

Synodic Month (or Lunar Month) is the interval between successive new Moons and is equal to 29.5306 days.
Tropical Year (or Solar Year) is the time taken for the Sun to complete one cycle of the ecliptic from spring equinox to spring equinox and is equal to 365.2422 days.
Tropical Month is the time taken for the Moon to complete one cycle of the ecliptic from spring equinox to spring equinox and is equal to 27.3216 days.
Nodical Month (or Draconic Month) is the time taken for the Moon to complete one cycle from ascending node to ascending node and is equal to 27.2122 days.
Nodical Year (or Eclipse Year) is the time taken for the Sun to complete one cycle from ascending node to ascending node and is equal to 346.6201 days.
Apogee Month (or Anomalistic Month) is the time taken for the Moon to complete one cycle from apogee to apogee and is equal to 27.5546 days.
Source: McMinn, 1995.

Appendix 6 MOON-SUN BACKGROUND INFORMATION

Apogee

Apogee is the point in the lunar orbit, where the Moon is the greatest distance from Earth, while perigee is the least distance. In the lunar apse cycle, the apogee – perigee axis (apsides) rotates counter clockwise around the ecliptical circle, with apogee passing from spring equinox to spring equinox every 8.8474 tropical years. The apsides axis is very important in oceanic tides on Earth. When the full/new Moon is at apogee, the amplitude of tides in New York Harbor is 50% lower than when the full/new Moon is at perigee. Apogee could be expected to play a key role in any Moon-Sun seismic effect.

9.0 divided by the 8.8474 year apse cycle yielded 1.02, while 56.0 divided by the apse cycle gave 6.33 (6 plus one third). Thus, every 9.0 years in the 9/56 year grid, apogee will be sited about 6^{o} further anticlockwise on the ecliptical circle. Every 56.0 years, apogee will be located 120 degrees further anticlockwise on the ecliptical circle. In the 9/56 year grid, apogee will therefore always located in three segments approximately 120 degrees apart on the ecliptical circle. For example, Table A gives the apogee position as on July 1 of those years in a 9/56 year grid. Apogee is always located in the following three segments 120 degrees apart 335 – 013 E^{o}; 095 – 135 E^{o} and 215 – 250 E^{o} with no exceptions.

Table A Appendix 6 9/56 YEAR CYCLE & THE POSITION OF APOGEE Ecliptical Degree of Apogee on July 1					
Sq 32	**Sq 41**	**Sq 50**	**Sq 03**	**Sq 12**	**Sq 21**
			1763 000	1772 007	1781 013
1792 100	1801 106	1810 113	1819 119	1828 126	1837 131
1848 219	1857 225	1866 231	1875 237	1884 244	1893 250
1904 337	1913 344	1922 350	1931 356	1940 002	1949 008
1960 096	1969 102	1978 108	1987 115	1996 121	2005 127
The 56 year sequences are separated by an interval of 9 years.					

Apogee takes 5.995 tropical years to complete one cycle ascending node to ascending node. The 18.0 year Saros eclipse cycle divided by 6 produced the integral number three and the 9 year Half Saros divided by 6 gave 1.5 (one plus a half). The 56 year cycle divided by 6 gave 9.3333 tropical years (9 plus one third). Thus the angle between the ascending node and apogee oscillates by about 180 degrees every 9.0 years and by about 120 degrees every 56.0 years. This is illustrated on the same date in Table B, which gives ascending node – apogee angles grouping 60^{o} apart in the angular circle with no exceptions.

Table B Appendix 6 9/56 YEAR CYCLE: ANGLE BETWEEN LAN & APOGEE Angle btn Ascending Node and Apogee on July 1					
Sq 32	**Sq 41**	**Sq 50**	**Sq 03**	**Sq 12**	**Sq 21**
			1763 341	1772 162	1781 342
1792 282	1801 102	1810 283	1819 103	1828 283	1837 103
1848 044	1857 224	1866 044	1875 224	1884 046	1893 225
1904 165	1913 346	1922 166	1931 346	1940 168	1949 346
1960 287	1969 107	1978 287	1987 108	1996 288	2005 108
The 56 year sequences are separated by an interval of 9 years. Abbreviation: LAN Lunar ascending node.					

Equinoxes

These points are sited where the plane of the Earth's equator projected out into the sky (celestial equator) cuts the plane of the Earth's orbit around the Sun (ecliptic). At these points, the equatorial ascending node is where the Sun crosses the celestial equator from south to north the celestial equator at 0 E° (0 Aries - vernal or spring equinox at around 20

March). The equatorial descending node is where the Sun crosses the celestial equator from north to south at 180 E° (0 Libra - autumnal equinox at around 22 September).

Lunar Ascending Node

The lunar nodes are imaginary points in the heavens, where the plane of the Earth's orbit around the Sun (the ecliptic) is cut by the plane of the Moon's orbit around the Earth. The ascending (north) node is where the Moon crosses the ecliptic from south to north, where as the descending (south) node is where the Moon crosses from north to south. In the lunar nutation cycle, it takes 18.62 years for the ascending node to complete one cycle from spring equinox to spring equinox.

Table C shows the ecliptical position of the lunar ascending node as on July 1 in a 9/56 year grid. This point is always found in two segments approximately 180 degrees apart in the ecliptical circle with no exceptions.

Table C Appendix 6
9/56 YEAR CYCLE & THE POSITION OF LAN
Ecliptical Degree of LAN on July 1

Sq 32	Sq 41	Sq 50	Sq 03	Sq 12	Sq 21
			1763 019	1772 205	1781 031
1792 178	1801 004	1810 190	1819 016	1828 202	1837 028
1848 175	1857 001	1866 187	1875 013	1884 199	1893 025
1904 172	1913 358	1922 184	1931 010	1940 196	1949 022
1960 169	1969 355	1978 181	1987 007	1996 193	2005 019

The 56 year sequences are separated by an interval of 9 years.
Abbreviation: LAN Lunar ascending node.