New Concepts in Global Tectonics NEWSLETTER

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REPORT OF EDPD-2011 INDIAN WORKSHOP, 21-24 SEPTEMBER, 2011

Controversies over scientific opinions are not uncommon in the evolution of the different branches of science. Creation versus evolution is one such prominent case that raged for a long. Big bang versus steady state is another example. Currently the world is gripped in a hot debate between those who believe the science of cause-and-effect relationship between CO_2 and global warming is established and those who believe the jury is still out. Indeed, among the later group there is a strong opinion that out rightly rejects this relationship. Because the subject has assumed open and direct political stage for reasons that are evidently going to impact future public welfare across the globe, it is not surprising that there is an unprecedented public involvement in the debate. Each piece of scientific data presented in favor or against the two opposing views is being subjected to intense scrutiny not just by opposing camps of scientists but also by interested citizenry. And media is not far behind. No doubt this public scrutiny has exposed and smeared many a scientific careers but it is expected to impose strict scientific ethics at least in climatology.

No other science or scientific controversy has had this benefit. We, the Earth scientists, know it first hand as for the current mainstream geodynamic concept, the plate tectonics, is concerned. Like the CO_2-induce global warming mantra, it caught the imagination of vast majority of Earth scientists although the fact remains that only 0.0001% of ocean floor had been mapped to any degree of certainty and vast tracks of continents remained unmapped by early 1960s when plate tectonics was formulated and propounded. However, right from its inception plate tectonics continued to be contested by scientists based in different parts of the world, though miniscule in overall numbers. Data continued to be presented that underscored its unviability and plate tectonicists continued to provide explanations that opposite camps labelled 'ad hoc fixtures.' However, over the time the opposite camp, like the global warming "skeptics," even lost platforms (journals, conferences) to present their data though ironically their numbers continued to increase.

It was courtesy dedication of a small group who find scientific difficulty with plate tectonics that a platform for scientists was created in 1996 in the form of 'New Concepts in Global Tectonics' with its Chapters in different countries and a Newsletter that would allow scientists of any opinion publish their data and interpretations if they have sound scientific grounds. Since its inception the Group has hugely increased in numbers, publishing online journal, *New Concepts in Global Tectonics Newsletter* and holding international meetings in different parts of the world at regular intervals.

It was in this backdrop that TRANSECT and NCGT have jointly organized this conference at Kanyakumari, southernmost India from 21st to 24th September to open a dialogue on recent development in global tectonics. In inaugural speeches both Transect and NCGT emphasized the vital role of field geology in understanding the Earth's geodynamic processes and wished this spirit to be succeeded by young scientists.

Other than the Indian Earth scientists, the workshop was attended by many overseas delegates including Australia, Azerbaijan, Columbia, Iran, Italy, Norway, and USA. In the workshop, a total of 20 oral and several poster presentations were made (see the list in pages 3-4). The papers covered a wide range of subjects: Earth's dynamic processes, Earth expansion, planetary influence on Earth's geodynamics, earthquakes, and mineral deposits. Reflecting recent unusually strong catastrophic seismic/volcanic and extreme weather events throughout the globe, however, the conference had a major thrust on earthquakes, their prediction and planetary interaction (60 % of the total presentations). Most of the papers were leading-edge researches and well-founded. Presentations were followed by an in-depth discussion in a friendly and relaxed atmosphere. The conference was eye-opening and inspirational for attendants, especially young scientists.

The conference was seamlessly organized by a team of TRANSECT despite the relatively short period of preparation. The cultural events (traditional Indian music, martial art and Hindu temple visit) were enjoyable and unique for overseas participants. Field visits and excursion provided precious chances to witness and discuss marvellous continental geology of India. The selfless dedication by organizers and supporting staff from the TRANSECT was highly admired by all participants. The Kanyakumari YMCA International Guest House provided us with comfortable conference facility and accommodation with delicious south Indian cuisines. We thank to all of them. It was a monumental, successful and enlightening gathering which will be recorded in the TRANSECT and NCGT history books.

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PROGRAM

21 September, 2011

17:00 Inaugural function
- Welcome, *Biju LONGHINOS* (Convener, EDPD)
- Introduction to NCGT, *Dong CHOI* (Editor, NCGT Newsletter)
- Introduction to Transect, *M. RAMASARMA* (Chairman, TRANSECT)
- Inaugural speech, *S. SINGANENJAM* (Director GSI)
- Felicitation, *C.G. NAMBIAR* (Prof. Geology, Cochin Univ. for Science and Technology)
- Vote of thanks, *S.N. KUMAR* (Reader, Dept. of Geol., Univ. of Kerala)

18:15 Tea break
18:30 Opening talk
- State of the art in global tectonics, *Karsten STORETVEDT* (Professor, Univ. of Bergen, Norway)

19:45 Dinner

22 September, 2011

7:30 – 9:00 Breakfast
9:30 Studies on interior Earth, planets and sun – the need for a straight forward and transparent approach, *Subhasis SEN*
10:15 Theoretical bases of one mechanism of mass-flow in the Earth inner structures. *Hatam GULIYEV*
10:50-11:10 Coffee/tea break
11:15 Earth's primeval make-up and its evolutionary course, *Karsten STORETVEDT*
11:50 Moon the controller of some major terrestrial geological features, *Subhasis SEN*
12:30-14:00 Lunch break
14:00 Tectonic interpretation of the Great East Japan Earthquake in March, 2011, *Dong CHOI*
14:45 The Neogene geodynamics in Iranian Plateau, *Soheila BOUZARI*
15:15-15:30 Coffee/tea break
15:30 Continental to oceanic crustal transition off the western continental margin of India and paradoxes in plate reconstructions scenarios in eastern Arabian Sea, *S. RANGARAJAN*
16:15 Solar-Earth dynamic interpretation in a new tectonic framework: potential for predicting natural hazards, *Bruce A. LEYBOURNE, Ismail BHAT and Santosh MISHRA*
17:00 Planet Earth and the expansion based concept of unified global tectonics, *Subhasis SEN*
17:30-18:30 Cultural event – Karnatic music by Ms. Nandana and party
19:30 Dinner

23 September, 2011

7:30 – 9:00 Breakfast
9:00 Radio anomalies and variations in the interplanetary magnetic field (IMF) used as seismic precursors on a global scale. *Valentino STRASER*
9:30 Earth tides and earthquakes. *Vinayak KOLVANKAR*
10:00 Satellite remote sensing in earthquake thermal precursors studies, *Arun K. SARAF*
10:30-10:45 Coffee/tea break
10:45 Solar polar rotation driving Madden-Julian oscillation's seismic teleconnections, *Bruce LEYBOURNE, Ismail BHAT and Santosh MISHRA*

11:15 Diurnal seismicity and temperature, *Vinayak KOLVANKAR*
11:45 Potential relationship between climate, earthquake and solar cyclicity in Apennines (Italy), *Valentino STRASER*
12:30-14:00 Lunch break
14:00 Gravitational stress: analysis and implications for earthquake prediction, *N. VENKATANATHAN* and *Karthik RAMANAN*
14:30 Seismic activities in relation to ionosphere, *Bindu MANGLA*
15:00 Sun, solar system dynamics and occurrence of major earthquake in India, *T.E. GIRISH*
15:15-15:30 Coffee/tea break
15:30 Significant results obtained so far, analyzing the data of super conducting gravimeter, installed at Ghuttu for earthquake precursors in Garhwal Himalayas, *Bhupendra Bahadur SINGH*
16:00 Aerosol behaviour over Ranchi, *Kumari LIPI*
16:30-17:30 Cultural event – Kalari Payattu, the martial art of Kerala
18:00 -19:30 Poster presentation
19:30 Dinner

24 September, 2011
Field visit
7:30-8:30 Putteti syenite
10:00-10:30 Kozhikkottupothai Mesozoic mafic dykes
11:15-11:45 Kottaram charnockites and Khondalite
13:30-15:00 Lunch at YMCA Guest House
15:00-18:30 Local visit (Swami Vivekananda Rock Memorial)
18:30-19:45 Valedictory function

25-30 September, 2011
Field excursion. Precambrian terrains of south India: Manapara granulitic terrain, Sittampundi ultrabasic-anorthositic terrain and Chitradurga Early Archean terrain.

Poster presentations:
Textural and compositional evolution of base metal mineralization and radioactive minerals vis-a-vis evolution of the Singhbhum Shear Zone at the Surda Mine section, Singhbhum-Orissa craton, Eastern India, *Sangita CHOWDHURY*

How our ancestors viewed natural hazards? – A glimpse through Sanskrit literature, *Anand Dilip RAJ and Biju LONGHINOS*

ABOUT THE 'TRANSECT'

The Transect is an organization of academicians, scientists and students from different areas of Earth sciences, thriving to make it democratic inquisitive and scientific. It was in 2007, a 'field goers' gathering initiated to motivate newer generation in geology with the spirit of field work, practices and ethics. The grouping later developed into a structured body in 2010, named the Transect, with Prof. M. Ramasarma as its founder Chairman.

The Transect focuses mainly to train students in Earth sciences, remedying the ill-effect of set trends. For example, the current trends in education for Geology give more importance to 3D graphics and computer-aided designs/virtual models to get answers for the geological questions than looking for answers in field, where most of the answers are hidden. As a result, students are being infused with theoretical information which are based on hit-and-trial method and no practical information. **The Indian industry, whether in mine or in oil fields, looks for candidates who have exposure to field geology knowledge which is actually the base of Geology. But the graphic model-driven academic pursuit of the day lacks the base which makes industry to run the business with team who knows to work on established theories. This makes Indian industries to look upon other international sources for research and development work. The Transect aims to infuse 'passion' in geology among the students, targets to proffer them wisdom and to equip them with 'industry ready'.**

The success of the Transect in pacing with this goal has enabled us to expand over South India and also to ally with Spirifer Geological Society, Poland and the organization of NCGT, Australia.

To support the aim, the Transect is looking forward for many more enthusiastic people to join and achieve this goal together for the better future of Earth science as subject and science.

Prof. M. Ramasarma
Chairman, 2010-2012
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Dr. B.K. Jishnu
Secretary, 2010-2012

After the conference in front of the YMCA Guest House, Kanyakumari.

PHOTO GALLERY OF THE EDPD-2011: Some relaxed moments.


Karnatic music by Ms. Nandana and party


Martial art of Kerala


Some overseas participants before the martial art performance

Hindu temple


Student helpers


At the entrance of the Hindu temple

LETTERS TO THE EDITOR

Dear Editor,

I'm writing to thank you on behalf of the Blot family for your action to commemorate our father when he died in June by publishing an obituary in your Newsletter. I'm sure he would have appreciated it. His work in the field of geophysics was the great passion of his life and despite his failing health – he maintained an interest until almost the end.

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Dykes, sills & volcanoes: the tectonic conditions

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In NCGT # 59, Cliff Ollier's piece on *Dykes, global tectonics and crustal expansion* presents a case for tensile conditions in the crust since dykes, in themselves, would be unable to force aside extensive crustal plates in order to achieve intrusion. His proposal is that dykes should be seen as infillers in already existing (tensile) cracks connecting the lithosphere with the Earth's surface.

One problem with this view is that, even neglecting the side friction involved in dyke intrusion, how would it be possible for dense dyke material to reach the surface within a less dense host environment, without some excess pressures at the base? A second problem relates to the conditions necessary for the spawning of sills. This is treated first.

Sills occur when a rising dyke encounters a layered situation, typically within a sedimentary regime, Figure 1. Admittedly, high temperatures in the feeder dyke and in the forefront of a sill could well vapourise moisture in the country rock and so assist in the separation of stratigraphic layers for sill emplacement, but emplacement of a sill still requires pressure/force from within the feeder dyke. If the dyke were a mere infiller of an already existing, open, tension crack, it would be unable to generate the pressure needed to emplace the sill.

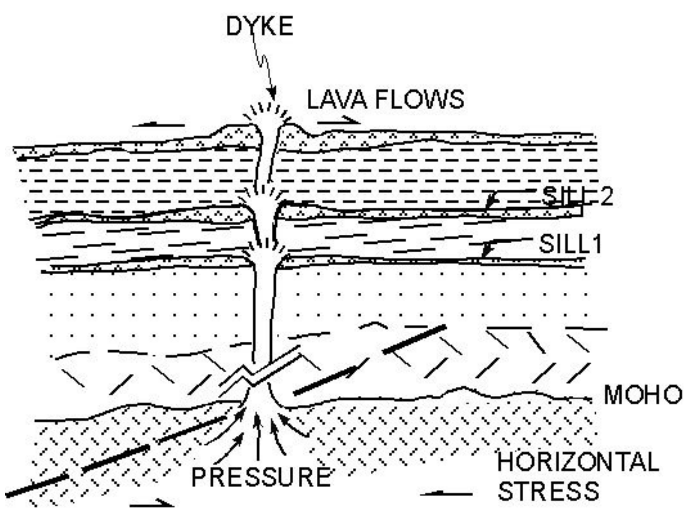

Figure 1. Feeder dyke and sill emplacement.

The pressure in the feeder dyke will also influence the distance to which the sill travels, since emplacement will necessarily terminate when the frictional resistance along either surface of the sill equals the driving force in the feeder dyke. For features like the Great Whin Sill, this implies very high pressures are at work. Incidentally, when the terminal stage of a sill is reached, the dyke – presumably still under pressure – would redirect its efforts to travel vertically once more, at least until it encounters another layered situation with a lower overburden pressure allowing it to emplace another sill, or until it reaches the surface. Provided there is still adequate driving force in the dyke, lavas would then pour out on the surface, or perhaps a volcano might be formed.

An analogy with sill emplacement can be drawn from a well-known problem in grouting procedures. Grouting pressures that are too high cause hydraulic fracture in a rock mass and/or separation of beds in a sedimentary series. Cases have been reported of grout cement emerging as much as a kilometer distant from a few small diameter injection pipes, the grout having travelled along favourable planes in the manner of sill emplacement. So, to take this to the next stage: what is the origin of the high pressures needed to produce geological sills?

Vertical stress is given near enough by overburden loading, so the only variable is the horizontal stresses. This would have to exceed the vertical stress by a considerable amount. Which is a state of compression. Jaegar, in his Methuen Monograph *Elasticity, Fracture & Flow,* discusses the role of hydraulic fracture in dyke emplacement but puts a depth restriction of some 7 – 8 km on its application. This is insufficient as a causative origin for most dykes, since dyke swarms frequently occur in shield areas where the thickness of sialic crust could exceed the above limitation by a factor of two or three. As Cliff Ollier points out there is also the problem of how sub-vertical cracks might exist, particularly in a crust under compression. A mechanism to account for compression-related subvertical cracks in the crust was partly outlined by the present writer in NCGT # 35, in a description of Reidel Shears. This description is briefly given again, below.

In the 1960s, at Imperial College, John Tchalenko smeared a veneer of clay over two contiguous boards which were then moved slowly and steadily relative to each other, Figure 2. The present author also tried the same simple experiment, using kaolinite which gave the clearest response. As the boards were moved as shown, two stages of Reidel Shears developed.

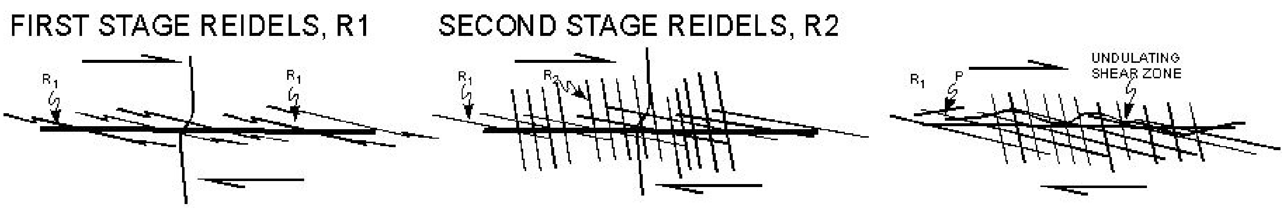

Figure 2. Development of failure patterns

- At small deformations, the first stage developed at an inclination of half the angle of friction of the material: for kaolinite, approximately 10 degrees.
- As the deformation increased, second stage Reidels became apparent. These took a form redolent of open tension fractures, inclined at an angle of 90 degrees less the angle of friction to the first set - for kaolinite, around 80 degrees to the line of contact of the boards. In geomechanics, the development of second stage Reidels is taken as heralding the approach of the full shear strength development.
- Obviously, further deformation cannot be dynamically accommodated by the system of the two Reidel Shears. Failure therefore occurs by a series of thrusts (P shears), joining up first stage Reidels to produce an undulating shear zone with intact lozenges. This pattern is found in nature from the micro stage to major transverse shears.

Now, if the two boards were rotated up 90 degrees, to the vertical, the upper board could be taken to represent the Earth's crust, the lower board the lithosphere with, perhaps, the interface between the boards representing the Moho. Small strains between the two domains could be imposed by tectonic forces such as a migrating (horizontal) geoid stress. This shearing effect between the crust and the lithosphere could conceivably produce both stage 1 and stage 2 Reidels, with the second stage being sub-vertical. As the underlying lithosphere comes under the same high horizontal stresses, heating could be expected while the developing state of compression would force magma up the tensile cracks of the second stage Reidels. It might also be noted that the second stage Reidels in the above experiment occur in swarm-like proportions, which also corresponds with the dyke swarms so often occurring in the Earth's crust. Hence a potential mechanism does exist for dyke/sill emplacement under pressure, without the need for crustal extension.

ARTICLES

9/56 YEAR CYCLE: EARTHQUAKES IN SELECTED COUNTRIES

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Abstract. A 9/56 year cycle has been established in the timing of major earthquakes in California – Nevada – Baja California (McMinn, 2011a). It was hypothesized that this cycle should also appear in the seismic catalogs from around the world. Surprisingly, this could be achieved for many countries such as Argentina, Australia, Chile, France, Iceland, New Zealand and so forth. However, the assessment was not completely successful, as a 9/56 year effect could not be determined for the UK, Turkey, Japan and Kamchatka (Russia). Hypothetically, a 9/56 year seismic effect should apply worldwide, but with major variation in patterning from region to region. This proposition could not be fully supported, given the observed anomalies. Hawaiian tsunamis were also considered in relation to the 9/56 year seismic grids for Chile and Alaska. Finally, the beginning of volcanic eruptions on Hawaii could be correlated with 9/56 year and 36/56 year cycles.

Keywords: *earthquake, 9/56 year, cycle, seismic, tsunami*

Introduction

A 9/56 year cycle was deciphered in patterns of major historic earthquakes in California – Nevada – Baja California, as well as in Hawaii (McMinn, 2011a). The obvious question arises as to whether this cycle was evident in other regions of the world. Or did it only apply to this portion of the Earth's surface for some peculiar reason? Historical earthquake catalogs were assessed for a possible 9/56 year effect in various countries – New Zealand, Iceland, Japan, Australia, Chile, Argentina, France, UK, Japan and so forth. It was proposed that a 9/56 year cycle should show up in all countries, but with major variations in the 9/56 year grids. On assessment, the 9/56 year effect did arise in the catalogues of most countries, although there were several exceptions. Tsunamis and eruptions on Hawaii were also considered in relation to the 9/56 year grid.

The 9/56 year cycle consists of a grid with 56 year intervals in the vertical columns and 9 year intervals on the horizontal rows. The vertical intervals of 56 years have been called sequences and the 9 year intervals on the horizontal sub-cycles. In this paper, the numbering of the 56 year sequences was based on that adopted by McMinn (Appendix 2, 2002), in which 1817, 1873, 1929, 1985 were denoted as Sequence 01; 1818, 1874, 1930, 1986 as Sequence 02 and so forth.

According to McMinn (2011a), the 9/56 year cycle was caused by Moon-Sun tidal effects. Any events clustering in a 9/56 year pattern will always have the lunar ascending node sited in two segments on the ecliptic approximately 180 degrees opposite with no exceptions. Apogee will also be located in three ecliptical segments 120 degrees apart with no exceptions. How this tidal triggering actually functions remains completely unknown. Please refer to McMinn (2011a) for background information on this Moon-Sun effect.

Chile

A comprehensive listing of major Chilean earthquakes (M =>7.8) between 1800 and 2010 was sourced from the Universidad de Chile (see **Appendix 1**). Of the total 25 earthquakes, 13 appeared in the year beginning April 1 of those years in **Table 1** (significant p < .01). All top five events (M => 8.4) since 1850 occurred in this table.

Importantly, the 9/56 year seismic pattern for Chile was markedly different to that established for Argentina (see subsequently). Given their close geographic proximity, the 9/56 year seismic grids in both countries could have been expected to align closely, but this was not observed.

Table 1
9/56 YEAR CYCLE: CHILEAN QUAKES 1800-2010 M => 7.8
Year beginning April 1

Sq 25	Sq 34	Sq 43	Sq 52	Sq 05	Sq 14	Sq 23	Sq 32	Sq 41	Sq 50	Sq 03	Sq 12	Sq 21
								1801	1810	**1819 0411**	1828	**1837 1107**
		1803	1812	1821	183	1839	1848	1857	1866	1875	1884	1893
1841	1850	1859	**1868 0813**	**1877 0509 1878 0123**	1886	1895	1904	1913 **1914 0129**	**1922 1110**	1931	1940	**1949 1217 1217**
1897	**1906 0816**	1915	1924	1933	1942	1951	**1960 0522**	1969	1978	1987	1996	**2005 0506**
1953	1962	1971	1980	1989	1998	2007	2014					
2009 **2010 0228**	2018											

Dates expressed as YYYYMMDD.
Years in **bold** contained major Chilean quakes (M => 7.8) in the year commencing April 1 of those years in the table.
Source of Earthquake Data: Universidad de Chile, Depto de Geofisica. Servicio Sismologico. http://www.sismologia.cl/seismo.html

Argentina
The Instituto Nacional De Prevencion Sismica listed some 57 Argentine (M =>5.0) earthquakes occurring between 1780 and 1995 (see **Appendix 2**). Of this figure, 32 took place in the year beginning January 20 of those years in **Appendix 3** (significant $p < 10^{-4}$). Of the 35 larger quakes (M => 6.0), 20 showed up in **Appendix 3** (significant $p < .001$). A seasonal trend in the timing of these events could not be detected.

Australia
Catalogs of major Australian earthquakes were sourced from the University of Western Australia. These were combined to give 31 major events (M => 6.0) for the 1870-2010 period (see **Appendix 4**), of which 14 appeared in the 9/56 year grid presented in **Table 2** (significant $p < .01$). The left hand side of **Table 2** experienced 9 earthquakes in the 6 months ended June 20, with one anomaly (Sep 19, 1885). On the right had side, all four events happened in the 6 months beginning June 20.

Remarkably, **Table 2** accounted for 20% of the complete 9/56 year grid, yet contained:
* 47% of all Australian quakes (M => 6.0).
* 58% of all major Australian quakes (M => 6.4).

Four major episodes were experienced in 1884 alone, while Sequence 12 contained 7 major Australian quakes (M => 6.3) in the 13 months beginning July 12 or about 33% of the total number.

Significance was associated with the more extreme events in Australian history. Of the 20 earthquakes with a magnitude => 5.9 and =< 6.3, only five fell in **Table 2**, which could have been expected by chance.

Table 2
9/56 YEAR CYCLE: AUSTRALIAN QUAKES 1870-2010 M => 6.0
Year beginning July 1

Sq 41	Sq 50	Sq 03	Sq 12	Sq 21	Sq 30	Sq 39	Sq 48	Sq 01	Sq 10	Sq 19
								1873 **Dec15**	1882	1891 **1892** **Jun26**
		1875	**1884** **Jul13** **Sep19** **1885** **Jan05** **May12**	1893	**1902** **Sep19**	1911	1920	**1929** **Aug16**	1938	1947
1913	1922	1931	1940 **1941** **Apr29** **Jun27**	1949	1958	1967	1976	1985	1994	2003
1969 **1970** **Mar24** **Mar25**	1978 **1979** **Jun02**	1987 **1988** **Jan22**	1996 (a)	2005						

The 56 year sequences are separated by an interval of 9 years.
Years in **bold** contained the biggest Australian earthquakes (M => 6.0) in the year commencing July 1.
(a) An earthquake occurred on August 10, 1997 (M 6.3) at Collier Bay, Western Australia.
Source of Earthquake Data: University of Western Australia

New Zealand

GNS Science presented a map of New Zealand's major earthquakes (M => 6.8) from 1840 to 2010, giving 'notable shallow (generally less than 30 kms deep) earthquakes since 1848' (see **Appendix 5**). Of the 21 episodes, 12 fell in the calendar years of the 9/56 year grid presented in **Table 3** (significant $p < .01$). Importantly, 13 major New Zealand earthquakes happened in the 1840-1950 era, of which 10 appeared in **Table 3** compared with an expected 3.3.

On the left hand side of **Table 3**, all 6 quakes took place in the 6 months beginning June 20. On the right hand side, five events happened in the 1.7 months ended March 10, with one anomaly (Jun 17, 1929).

Table 3
9/56 YEAR CYCLE: NEW ZEALAND QUAKES 1840-2010 M => 6.8
Year commencing January 1

Sq 52	Sq 05	Sq 14	Sq 23	Sq 32	Sq 41	Sq 50	Sq 03	Sq 12	Sq 21	Sq 30	Sq 39	Sq 48	Sq 01
										1846	**1855** **0123**	1864	1873
				1848 **1016**	1857	1866	1875	1884	**1893** **0212**	1902	1911	1920	**1929** **0309** **0617**
1868 **1019**	1877	1886	1895	1904	1913	1922	**1931** **0202** **0213**	1940	1949	1958	1967	1976	1985
1924	1933	**1942** **0624** **0802**	1951	1960	1969	1978	1987	1996	2005				

1980	1989	1998	**2007 0930 1220**										
Dates expressed as YYYYMMDD. Years in **bold** contained major NZ earthquakes in the year commencing January 1. **Source of Earthquake Data**: GNS Science.													

Significance could also be achieved via an 18/56 year grid shown in **Table 4**. Nine major New Zealand earthquakes happened within this table, in contrast to an expected 2.6.

Table 4 **18/56 YEAR CYCLE: NEW ZEALAND QUAKES 1840–2009 (M =>6.8)** **Year beginning January 1**						
Sq 23	Sq 41	Sq 03	Sq 21	Sq 39	Sq 01	Sq 19
				1855 Jan23	1873	1891
1839	1857	1875	**1893 Feb12**	1911	**1929 Mar09 Jun17**	1947
1895	1913	**1931 Feb02 Feb13**	1949	1967	1985	**2003 Aug22**
1951	1969	1987	2005			
2007 Sep30 Dec20						
The 56 year sequences are separated by an interval of 18 years. Years in **bold** contained major NZ earthquakes in the year commencing January 1. **Source of Earthquake Data**: GNS Science.						

France

SISMALP – French Alps Seismic Network released a comprehensive listing of "historical quakes which have occurred in south-east [France] and the areas bordering on Switzerland and Italy for which the maximum intensity reached or exceeded VII" (see **Appendix 6**). For the period to 1750 to 2000, SISMALP gave some 61 earthquakes for the south east region, with 28 falling in the 9/56 year pattern presented in **Appendix 7** (significant $p < .001$). Strangely, 13 events happened in only five sequences (see **Table 5**), of which 6 occurred in July and five in the 6 weeks ended April 20. Two anomalies took place in late 1855.

Table 5 9/56 YEAR CYCLE: **QUAKES IN SOUTH EAST FRANCE 1750–2000** **Year beginning January 1**								
Sq 30		Sq 39		Sq 48		Sq 01		Sq 10
				1752	+ 9	1761	+ 9	1770
1790	+ 9	1799	+ 9	**1808 Apr02 Apr02 Apr16**	+ 9	**1817 Mar11**	+ 9	1826
1846	+ 9	**1855 Jul25 Jul26 Jul26 Oct28**	+ 9	1864	+ 9	**1873 Jul14 Jul19**	+ 9	1882

		Dec12						
1902	+ 9	1911	+ 9	1920	+ 9	1929	+ 9	**1938 Jul18**
1958 Mar30	+ 9	1967	+ 9	1976	+ 9	1985	+ 9	1994
Source of Earthquake Data: SISMALP.								

Iceland
The Icelandic Meteorological Office published a listing of 25 Icelandic earthquakes (M = > 6.0) between 1706 and 2000 (see **Appendix 8**). Amazingly, none of these events (M => 6.0) took place in the four months beginning September 10. Some 20 Icelandic quakes fell in the 9/56 year grid shown in **Appendix 9** (significant $p < .001$), with 10 in the 4.5 months ended June 5 and 9 in the month ended September 6. An anomaly happened on January 13, 1976.

India
23 major earthquakes were presented in Earthquake History of India and How safe are we? (see **Appendix 10**), with 13 occurring the 9/56 year grid shown in **Table 6** (significant $p < .01$). More notably, 10 took place preferentially in the 8 months ended August 30 in the table, where as the expected frequency was around 2.7. Unfortunately, only limited information was available for pre 1850 Indian quakes.

On the left hand side of **Table 6**, all four earthquakes happened in the three months to April 4. On the right hand side, 7 quakes happened in the three months ended August 21, with two exceptions (Dec 10, 1967 and Oct 8, 2005).

Table 6 9/56 YEAR CYCLE: INDIAN EARTHQUAKES 1850-2010
Year ended August 30

Sq 53	Sq 06	Sq 15	Sq 24	Sq 33	Sq 42	Sq 51	Sq 04	Sq 13	Sq 22	Sq 31	Sq 40	Sq 49	Sq 02
											1856	1865	1874
					1858	1867	1876	**1885 0530**	1894	1903	1912	1921	**1930 0702**
1869 0110	1878	1887	1896	**1905 0404**	1914	1923	1932	**1941 0626**	**1950 0815**	1959	1968 **1967 1210**	1977	1986
1925	**1934 0115**	1943	1952	1961	1970	1979	**1988 0806 0821**	**1997 0522**	2006 **2005 1008**				
1981	1990	**1999 0329**	2008	2017									

Dates expressed as YYYYMMDD.
Major Indian quakes in **bold** occurred in the year ended August 30.
Source of Earthquake Data: Earthquake History of India

Italy
Instituto Nazionale di Geofisica e Vulcanologia provided a comprehensive catalog of historic Italian quakes, which yielded a listing of 35 events with a magnitude => 6.00 since 1750 (see **Appendix 11**). A clustering effect within the complete 9/56 year grid could not be detected at the $p < .01$ level. However, only three events were experienced in the 9/56 grid as presented in **Appendix 12**, which comprised 34% of the complete 9/56 year grid, yet contained only 9% of all major earthquakes.

Taiwan
The Central Weather Bureau of Taiwan (pers com) kindly provided a listing of the 39 major Taiwanese earthquakes (M => 7.0) occurring between 1900 and 2004 (see **Appendix 13**). These episodes did not group into a 9/56 year pattern with significance at the $p < .01$ level. Even so, very few Taiwanese events took place

in the 9/56 year grid between the Sequences 46 to 29 (see **Appendix 14**). In fact, only 7 quakes happened in the 24 sequences, where as about 17 could have been anticipated by chance (significant p < .01).

Alaska, USA

The US Geological Survey presented a listing of 25 major Alaskan earthquakes (M => 7.5) from 1898 to 2010 (see **Appendix 15**). Some 13 fell in the 9/56 year pattern given in **Table 7** (significant p < .01). Of the top 7 episodes (M => 8.0), 6 appeared in the table compared with an expected 1.5.

Table 7
9/56 YEAR CYCLE: ALASKAN EARTHQUAKES 1898-2010 M => 7.5
Year ended November 5

Sq 02	Sq 11	Sq 20	Sq 29	Sq 38	Sq 47	Sq 56	Sq 09	Sq 18	Sq 27	Sq 36	Sq 45
									1899 0904 0910	1908	**1917 0531**
		1892	1901	1910	1919	1928	1937	**1946 0401**	1955	**1964 0324**	1973
1930 **1929 1217**	1939 **1938 1110**	1948 0514	**1957 0309**	1966	**1975 0202**	1984	1993	**2002 1103**	2011		
1986 0507	1995	2004 **2003 1217**									

Dates expressed as YYYYMMDD.
Each 56 year sequence is separated by an interval of 9 years.
Events (M =>7.5) in **bold** occurred in the 12 months ended November 5.
Source of Raw Data: US Geological Survey. Earthquakes in the United States. Magnitude 7.0 and Greater. http://earthquake.usgs.gov/earthquakes/states/large_usa_7.php

Anomalies

A 9/56 year cycle could not be established for some countries at the p < .01 level, something that applied to Japan, the UK, Turkey and Kamchatka (Russia). A 9/56 year effect was expected to be established for all countries and regions, but with varying 9/56 year configurations. The anomalies did not support this proposition.

Parkfield Earthquakes

The Parkfield earthquakes in California were the most famous seismic cycle in US history. The first happened on January 9, 1857, with subsequent quakes taking place increasingly later in the solar year - February 2, March 3, March 10, June 8, June 28, with the last event on September 28. The quakes also occurred at a reasonably regular interval of 20 to 24 years between 1857, 1881, 1901 and 1922, while 1966 was some 2 x 22 years after the 1922 event (see **Table 8**). The 1934 and 2004 episodes deviated radically from the ideal 20 to 24 year periodicity. NB. Degrees on the ecliptical circle have been denoted as E°, while angular degrees between the Moon and Sun (lunar phase) have been given as A°. This was to distinguish between two different concepts.

Table 8 PARKFIELD EARTHQUAKES & MOON-SUN DATA

Date	M	UT	Sun E°	Moon E°	Phase A°	AN E°	Apo E°
Jan 09, 1857	7.9	16.00	289	100	171	010	206
Feb 02, 1881	5.8	00.11	313	354	041	265	105
Mar 03, 1901	6.4	07.45	342	139	157	237	202
Mar 10, 1922	6.3	11.21	349	127	138	190	337

Jun 08, 1934	6.0	04.47	077	032	315	313	116
Jun 27, 1966	6.0	04.26	095	206	111	053	340
Sep 28, 2004	6.0	17.15	186	008	182	033	096
Abbreviations: AN – Ascending node. Apo – Apogee point.							

Five Parkfield events happened in one sector of the complete 9/56 year cycle (see **Table 9**), where as chance would indicate about 0.9. All five episodes also had lunar phase from 110 to 185 A°. Two Parkfield earthquakes took place with phase outside this range – February 2, 1881 (041 A°) and June 8, 1934 (315 A°).

Table 9
THE 9/56 YEAR CYCLE:
PARKFIELD EARTHQUAKES & LUNAR PHASE
12.3 months ending March 10

Sq 41	Sq 50	Sq 03	Sq 12	Sq 21	Sq 30	Sq 39
						1855
1857 Jan09 171 A°	1866	1875	1884	1893	1902 **1901 Mar03 157 A°**	1911
1913	**1922 Mar10 138 A°**	1931	1940	1949	1958	1967 **1966 Jun27 111 A°**
1969	1978	1987	1996	2005 **2004 Sep28 182 A°**	2014	

A 44 - 65 year grid appeared between four Parkfield earthquakes (1857, 1901, 1922 & 1966), which was based on intervals of about 44 and 65 solar years (see **Table 10**). Lunar phase for the four quakes ranged from 110 to 175 A°, while the ecliptical position of apogee happened at 206 E° (1857) and 202 E° (1901), as well as at 337 E° (1922) and 340 E° (1966). The three Parkfield earthquakes outside this grid had apogee located from 095 to 120 E°.

Table 10
PARKFIELD QUAKES & THE 44/65 YEAR GRID

Solar Year Intervals		
Jan 9, 1857	+ 65.16	Mar 10, 1922
+ 44.14		+ 44.30
Mar 03, 1901	+ 65.32	Jun 27, 1966
Synodic Month Intervals & Lunar Phase		
Jan 9, 1857 171 A°	+ 805.94	Mar 10, 1922 138 A°
+ 545.96		+ 547.90
Mar 03, 1901 157 A°	+ 807.87	Jun 27, 1966 111 E°
Apogee E°		
Jan 9, 1857 206 E°	+ 131°	Mar 10, 1922 337 E°
- 004°		+ 003°
Mar 03, 1901	+ 138°	Jun 27, 1966

202 E°		340 E°
Ascending Node E°		
Jan 09, 1857 010 E°	+ 180°	Mar 10, 1922 190 E°
+ 227°		+ 223°
Mar 03, 1901 237 E°	+ 176°	Jun 27, 1966 053 E°

Overall, the findings on the Parkfield series were only ‘interesting’, as the sample size was too tiny to draw any conclusions. The author looked at the prospect of seismic grids, but nothing very precise could be produced. In contrast, financial grids can be very exact, with a few examples being presented in **Appendix 21**.

Hawaiian Tsunamis

Tsunamis striking the Hawaiian coast (run up => 1 metre) over the past two centuries could not be correlated with the 9/56 year grid at the $p < .01$ level, based on data from the National Geophysical Data Center (NGDC). However, 13 Chilean quakes were listed as causing tsunamis in Hawaii (see **Appendix 16**), of which 9 appeared in **Table 1** - a 9/56 year pattern containing numerous major Chilean events. Similarly, many Hawaiian tsunamis from Alaskan sources showed up in **Table 7**, a grid accounting for various major Alaskan episodes.

The 9/56 year seismic layouts for Chile and Alaska were very different, which may help explain why the full listing of Hawaiian tsunamis failed to produce 9/56 year correlates. Furthermore, a 9/56 year seismic grid could not be established for Japan or Kamchatka and thus no 9/56 year pattern was discernable for Hawaiian tsunamis generated from these sources.

Lander and Lockridge (1989) produced a catalog of 26 Hawaiian tsunamis (run up => 1 meter) for the period 1815 - 1975 (see **Appendix 17**). Of this total, 12 fell in the 9/56 year grid as shown in **Table 11**, a finding that was significant ($p < .01$). There were 8 tsunamis originating from earthquakes in Chile, of which 7 occurred in **Table 1**.

Table 11 9/56 YEAR CYCLE: HAWAIIAN TSUNAMIS 1810-1975 run up > 1m
Year beginning March 1

Sq 34	Sq 43	Sq 52	Sq 05	Sq 14	Sq 23	Sq 32	Sq 41	Sq 50	Sq 03	Sq 12	Sq 21
								1810	**1819 0412**	1828	1837 1107
		1812	1821	1830	1839	1848	1857	1866	1875	1884	1893
1850	1859	**1868 0403 0813 1002**	**1877 0510 1878 0120**	1886	1895	1904	1913	**1922 1111 1923 0202**	1931	1940	1949
1906 0817	1915	1924	**1933 0302**	1942	1951	**1960 0522**	1969				
1962	1971										

Dates given as YYYYMMDD.
Hawaiian tsunamis highlighted in **bold** fall in the year beginning March 1.
Source of Raw Data: After Lander & Lockridge (1989).

The 18/56 year grid in **Table 12** contained 50% of all NDGC listed tsunamis (run up => 1 metre) generated from Hawaiian sources.

Table 12 18/56 YEAR CYCLE: HAWAIIAN TSUNAMIS GENERATED FROM LOCAL QUAKES 8 months ending May 30						
Sq 52	Sq 14	Sq 32	Sq 50	Sq 12	Sq 30	Sq 48
						1864
			1866	1884	1902	1920 **1919** **Oct02**
1868 **Apr02**	1886	1904 **1903** **Nov29**	1922	1940	1958	1976 **1975** **Nov29**
1924 **May30**	1942	1960	1978			
1980	1998	2016	1989			

The 56 year sequences are each separated by an interval of 18 years.
Years in **bold** contained major Hawaiian tsunamis (run up => 1.0 m) in the 8 months ended May 30.
Source of Tsunami Raw Data: NGDC.

Hawaiian Volcanoes

The beginning of Kilauea and Mauna Loa eruptions has been well documented by the US Geological Survey (see **Appendices 18 & 19** respectively). For the 58 eruptions by the Kilauea volcano since 1823, 23 commenced in the 9/56 year grid as presented in **Table 13**. Mauna Loa recorded 33 episodes since 1843, of which 11 happened in the table. Combining these two sets of data gave 34 eruptive beginnings, which was significant $p < .01$. It would have been curious to see if the maximum intensity of Hawaiian eruptions could have been linked to the 9/56 year cycle. Alas, such raw data was not available.

Table 13 9/56 YEAR CYCLE: HAWAIIAN ERUPTIONS 1820-2010 Year ending July 31													
Sq 52	Sq 05	Sq 14	Sq 23	Sq 32	Sq 41	Sq 50	Sq 03	Sq 12	Sq 21	Sq 30	Sq 39	Sq 48	Sq 01
								1828	1837	1846	1855	1864	**1873** **#**
	1821	1830	1839	1848	1857	**1866** **#**	1875	**1884** *****	**1893** **#**	1902	1911	**1920** ***#**	**1929** ******
1868 ****#**	**1877** ****#**	1886	1895	**1904** **##**	1913	**1922** *****	**1931** *****	**1940** **#**	**1949** **#**	1958	1967	**1976** *****	1985
1924 *******	1933	**1942** **#**	1951	**1960** ******	**1969** ********	**1978** *****	1987	1996	2005				
1980 *****	1989	1998	2007										

* Denoted the beginning of a Kilauea eruption.
# Denotes the beginning of a Mauna Lao eruption.
Dates given as YYYYMMDD.
The 56 year sequences are separated by an interval of 9 years.
Years in **bold** contained the beginning of Hawaiian eruptions in the year ending July 31.
Source of Raw Data: US Geological Survey.

Much higher significance was achieved using 36/56 year grids. Kilauea and Mauna Loa experienced 28 eruptive beginnings within the 36 year sub-cycles in Grids 1 & 2 (significant $p < 10^{-5}$) (see **Appendix 20**). Grid 2 was displaced relative to Grid 1 by 9 years (ie: Grid 2 plus 9 years gives Grid 1) and thus may be amalgamated into a grid repeating the 9, 27, 9, 27…. years on the horizontal and 56 years on the vertical (denoted as a 9-27/56 year cycle) (see **Table 14**).

Table 14
9-27/56 YEAR CYCLE: BEGINNING OF HAWAIIAN ERUPTIONS 1820 – 2010
Year ending July 31

Sq 52		Sq 05		Sq 32		Sq 41	
				1848	+ 9	1857	+ 27
1868 ****#**	+ 9	**1877** ****#**	+ 27	**1904** **##**	+ 9	1913	+ 27
1924 *******	+ 9	1933	+ 27	**1960** ******	+ 9	**1969** ********	+ 27
1980 *****		1989					
Sq 12		Sq 21		Sq 48		Sq 01	
1828	+ 9	1837	+ 27	1864	+ 9	**1873** **#**	
1884 *****	+ 9	**1893** **#**	+ 27	**1920** ***#**	+ 9	**1929** ******	
1940 **#**	+ 9	**1949** **#**	+ 27	**1976** *****	+ 9	1985	
1996	+ 9	2005					

* Denoted the beginning of an eruption at Kilauea.
# Denoted the beginning of an eruption at Mauna Lao.
Years presented in **bold** contained eruptions in the year ending July 31.
Source of Raw Data: USGS.

Discussion

Good correlates at $p < .01$ could be established between the 9/56 year grid and the historic earthquake catalogs for many countries. Even so, the outcome was not consistent, as some countries did not show a 9/56 year effect, such as the UK, Japan, Turkey and Kamchatka (Russia). No explanation may be given why some countries failed to yield 9/56 year significance. The 9/56 year grid can be intimately linked to Moon-Sun cycles, a topic extensively covered by McMinn (2010a) so it will not be reiterated here. His paper is recommended reading for those interested in the concept.

Sunspot Cycle. To date a 9/56 year cycle has been established for finance (McMinn, 1993), earthquakes (McMinn, 2011a, 2011b) and hurricanes (McMinn, 2011c) and all three phenomena have been linked to sunspot cycles.

Krivelyova and Robotti (2003) found that high geomagnetic storm activity induced stock market declines the following week. The outcome was statistically and economically significant. The size of the geomagnetic storm effect was similar within and across countries, ranging between 0.77% and 4.4% of average annual returns. According to the authors, substantially higher stock market returns were recorded during periods of quiet geomagnetic activity.

Hodges and Elsner (2010) showed that the likelihood of three or more hurricanes hitting the US coast rises from 20% to 40% in years when sunspot activity is in the lowest 25%, compared with years in the highest 25%. During peak sunspot years, there is only a 25% chance of one or more hurricanes hitting the USA, a figure that spikes to 64% in the lowest sunspot years.

For the 1973-2010 period, Choi and Maslov (2010) found that earthquake frequency was “closely related to the solar [sunspot] cycle: the number of earthquakes increases during the declining/trough periods.” The authors also listed numerous additional references on sunspot - earthquake cycles.

The relationship between the 9/56 year Moon-Sun cycle and the sunspot cycle remains very enigmatic.

Planetary Cycles. Planetary cycles are quite irregular when viewed from Earth. If the planets did play a major role in earthquake timing, the neat 9/56 year grids found in seismology should not arise. In contrast, Moon-Sun cycles are repeatable, very precise and very closely align with the 9/56 year grid. Additionally, the planets exert extremely faint tidal influences on the Earth's surface that are much, much weaker than the lunisolar tidal effect. It is debatable whether such weak planetary forces are detectable in the noise of seismic activity. Based on research to date, these weak planetary forces have yet to be confirmed in seismic cycles. However, new studies may reverse such findings. This could possibly be achieved through the analysis of sunspot frequency, which has been directly linked to Jupiter cycles (Wikipedia).

Latitudinal Passage. There may be similarities in earthquake cycles at the same latitude north and south of the equator – something that needs to be appraised. The sunspot cycle offers the best example of latitudinal passage. At the beginning of a new cycle, sunspots mainly occur at about 40^o latitude north and south of the solar equator. These sunspots emerge at lower and lower latitudes with increasing activity until the cycle peaks in number at about 15^o north and south. This peak wanes as the sunspots move closer to the equator. When activity reaches a minimum, sunspots of the new cycle start forming at the 40^o latitudes, while those from the old cycle occur near the equator. Over the whole cycle there is a progressive drift of sunspots from the higher latitudes towards the equator. Latitudinal passage may involve a fundamental principle that could also manifest in terrestrial seismic cycles.

Plate Tectonics. The question may be raised – Are the Moon and Sun influential in determining how continents split and collide? What causes the formation of the African rift valley, the mid Atlantic ridge or the Himalayas on the Earth's surface? This was pure speculation, but still needed some consideration.

Volcanoes. A 9/56 year eruption cycle could not be confirmed from the work so far undertaken by the author. Only a few favorable 9/56 year correlates could be achieved, based on raw data sourced mainly from the National Geophysical Data Center. Several countries/regions showed a 9/56 year earthquake cycle, but did not yield a similar volcanic cycle. However, the beginnings of eruptions on Hawaii did correlate with the 9/56 and 36/56 year grids in **Tables 13 & 14** respectively.

Finally, how the 9/56 year seismic cycle changes over the very long term could also be assessed from catalogs covering centuries of data. Such trends should occur, given the secular changes evident in Moon-Sun cycles.

Conclusions

A 9/56 year cycle could be established in various countries and regions around the world such as south west North America (McMinn, 2011), Chile, Argentina, Australia, New Zealand, France, Iceland and India. For Italy and Taiwan, large sections of the complete 9/56 year grid contained very few earthquakes, which also yielded significance at $p < .01$. Quake listings for several US states showed a 9/56 year influence, but were not included in this paper apart from Alaska. Despite such favourable findings, some catalogs failed to produce a 9/56 year effect at $p > .01$, an outcome that was apparent for Japan, the UK, Turkey and Kamchatka (Russia). A 9/56 year cycle could be reasonably hypothesized to apply worldwide, but with varying 9/56 year patterning arising from Moon-Sun tidal influences. This was not observed and no explanation can be offered for the failure of some countries to yield a 9/56 year effect.

Hawaiian tsunamis originating from Chile and Alaska may occur preferentially in 9/56 year grids as in **Tables 1 & 7** respectively. Furthermore, the beginning of Hawaiian volcanic eruptions also took place preferentially in 9/56 year and 36/56 year grids. The prospect of 9/56 year patterns for tsunamis and eruptions has not been researched in much detail by the author and this topic remains to be more fully explored.

The findings of McMinn (2011a & 2011b) and this assessment were generally supportive of a 9/56 year cycle in the timing of major earthquakes around the world. However, current understanding of this phenomenon was extremely limited and much more follow up research was imperative.

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Appendix 1 CHILEAN EARTHQUAKES 1800-2010 M =>7.8				
Date	**Time**	**Latitude**	**Longitude**	**Ms**
11/04/1819	**10:00**	**-27.35**	**-70.35**	**8.3**
19/11/1822	22:30	-33.05	-71.60	8.5
08/10/1831	06:00	-	-	7.8
20/02/1835	11:30	-36.83	-73.03	8.5
07/11/1837	**08:00**	**-39.80**	**-73.20**	**8.0**
13/08/1868	**16:45**	**-18.50**	**-70.35**	**8.5**
09/05/1877	**21:16**	**-19.60**	**-70.23**	**8.5**
23/01/1878	**08:00**	**-20.00**	**-70.30**	**7.9**
16/08/1906	**19:48**	**-33.00**	**-72.00**	**7.9**
29/01/1914	**23:30**	**-35.00**	**-73.00**	**8.2**
20/05/1918	12:57	-28.50	-71.50	7.9
04/12/1918	07:47	-	-	8.2
10/11/1922	**23:53**	**-28.50**	**-70.00**	**8.4**
01/12/1927	00:06	-35.00	-72.00	8.3
25/01/1939	23:32	23.32	72.25	8.3
06/04/1943	12:07	-30.75	-72.00	8.3
02/08/1946	15:19	25.50	70.50	7.9
17/12/1949	**02:53**	**-54.00**	**-71.00**	**7.8**
17/12/1949	**11:07**	**-54.000**	**-71.00**	**7.8**
09/12/1950	17:38	23.50	67.50	8.3
22/05/1960	**15:11**	**-39.50**	**-74.50**	**8.5**
28/12/1966	04:18	-25.51	-70.74	7.8
03/03/1985	19:46	-33.24	-71.85	7.8
06/05/2005	**18.44**	**29.90**	**69.13**	**7.8**
27/02/2010	**12.40**	**22.31**	**70.08**	**8.8**

Events in **bold** fall in year beginning April 1 of those years in **Table 1**.
Source: Universidad de Chile, Depto de Geofisica. Servicio Sismologico.
http://www.sismologia.cl/seismo.html.

Appendix 2 9/56 YEAR CYCLE: ARGENTINE QUAKES 1780-1995 Year beginning January 20						
Year	**Month**	**Day**	**Lat**	**Long**	**M**	**Int**
1782	**5**	**22**	**33.00**	**69.20**	**7.00**	**VIII**
1817	7	4	28.00	64.50	7.00	VIII
1826	**1**	**19**	**26.20**	**65.25**	**6.40**	**VIII**
1844	10	18	24.80	64.70	6.50	VII
1861	**3**	**20**	**32.90**	**68.90**	**7.00**	**IX**
1863	1	14	23.60	65.00	6.40	VIII
1871	10	9	23.10	64.30	6.40	VIII
1874	**7**	**6**	**23.00**	**64.20**	**6.00**	**VII**
1888	6	5	34.60	57.90	5.50	VI
1892	**3**	**21**	**29.50**	**65.00**	**6.00**	**VII**
1894	10	27	29.80	69.00	8.00	IX
1898	2	5	28.45	66.15	6.40	VIII
1899	**3**	**23**	**22.10**	**63.80**	**6.40**	**VIII**
1899	**4**	**12**	**28.65**	**68.40**	**6.40**	**VIII**
1903	8	12	32.10	69.10	6.00	VII
1906	11	17	26.75	65.70	6.00	VII

1907	8	11	27.20	65.50	5.50	VI
1908	**2**	**5**	**25.20**	**64.70**	**6.00**	**VII**
1908	**9**	**22**	**30.50**	**64.50**	**6.50**	**VII**
1913	11	6	26.80	65.10	5.50	VI
1917	**7**	**27**	**32.30**	**68.90**	**6.50**	**VII**
1920	12	17	32.70	68.40	6.00	VIII
1927	4	14	32.00	69.50	7.10	VIII
1929	5	23	32.90	68.90	5.70	VI
1929	5	30	35.00	68.00	6.80	VIII
1930	**12**	**24**	**24.70**	**66.30**	**6.00**	**VIII**
1931	4	3	27.00	65.00	6.30	VII
1933	2	12	26.60	65.35	5.50	VI
1934	6	11	33.50	64.50	6.00	VIII
1936	5	22	32.00	66.00	6.00	VIII
1941	7	3	31.80	67.80	6.20	VII
1944	1	15	31.40	68.40	7.40	IX
1947	**1**	**16**	**31.10**	**64.50**	**5.50**	**VII**
1948	**1**	**21**	**30.50**	**58.00**	**5.50**	**VI**
1948	**8**	**25**	**24.90**	**64.80**	**7.00**	**IX**
1949	12	17	54.00	68.77	7.80	VIII
1952	6	11	31.60	68.60	7.00	VIII
1955	**3**	**28**	**30.80**	**45.70**	**6.90**	**VI**
1957	10	24	28.90	68.00	6.00	VII
1959	**5**	**12**	**23.18**	**64.65**	**6.80**	**VIII**
1966	**10**	**21**	**27.72**	**62.34**	**5.00**	**VII**
1966	**11**	**10**	**31.95**	**68.40**	**5.90**	**VI**
1967	4	25	32.72	69.17	5.40	VI
1968	**10**	**15**	**26.87**	**60.88**	**5.00**	**VI**
1972	9	26	30.90	68.21	5.80	VI
1973	**11**	**3**	**25.98**	**67.71**	**5.80**	**VI**
1973	**11**	**19**	**24.57**	**64.58**	**5.40**	**VII**
1974	8	17	23.30	64.40	5.00	VII
1977	**6**	**7**	**29.74**	**67.80**	**5.10**	**VII**
1977	**11**	**23**	**31.04**	**67.76**	**7.40**	**IX**
1977	**12**	**6**	**31.23**	**67.90**	**5.90**	**VI**
1978	**1**	**17**	**31.25**	**67.99**	**5.70**	**VI**
1981	5	9	26.57	64.89	5.00	VI
1985	1	26	33.12	68.82	5.90	VIII
1992	2	29	26.68	64.93	5.20	VI
1993	**6**	**8**	**31.56**	**69.23**	**6.50**	**VI**
1993	**10**	**30**	**31.70**	**68.23**	**5.90**	**VI**
Argentine quakes denoted in **bold** happened in the year beginning January 20 of those years in **Appendix 3.** **Source**: Instituto Nacional De Prevencion Sismica						

Appendix 3 **9/56 YEAR CYCLE: ARGENTINE QUAKES 1780-1995** **Year beginning January 20**							
Sq 22	Sq 31	Sq 40	Sq 49	Sq 02	Sq 11	Sq 20	Sq 29
							1789

1782 May22	1791	1800	1809	1818	1827	1836	1845
1838	1847	1856	1865	**1874 Jul06**	1883	**1892 Mar21**	1901
1894 Oct27	1903 Aug12	1912	1921	**1930 Dec24**	1939	**1948 Jan21 Aug25**	1957 Oct24
1950	**1959 May12**	**1968 Oct15**	**1977 Jun07 Nov23 Dec06 1978 Jan17**	1986	1995	2004	
2006							
Sq 38	Sq 47	Sq 56	Sq 09	Sq 18	Sq 27	Sq 36	Sq 45
					1787	1796	1805
1798	1807	1816	1825 **1926 Jan19**	1834	1843	1852	**1861 Mar30**
1854	1863	1872	1881	1890	**1899 Mar23 Apr12**	**1908 Feb05 Sep22**	**1917 Jul27**
1910	1919	1928	1937	1946 **1947 Jan16**	**1955 Mar28**	1964	**1973 Nov03 Nov19**
1966 Oct21 Nov10	1975	1984	**1993 Jun08 Oct30**	2002	2011		
The 56 year sequences are separate from each other by an interval of 9 years. Years in **bold** contain major Argentine earthquakes in the year beginning January 20 of those years in the table. **Source of Earthquake Data**: Instituto Nacional De Prevencion Sismica							

Appendix 4 MAJOR AUSTRALIAN QUAKES 1870-2010 (M => 5.9)		
M	**Date**	**Location**
7.6	Nov 19, 1906	Indian Ocean offshore WA
7.1	**Apr 29, 1941**	**Meeberrie, WA**
7.1	Dec 12, 2001	Southern Ocean, offshore Albany WA
6.9	**Jun 26, 1892**	**Offshore Flinders Island, Tas**
6.8	**May 12, 1885**	**Offshore Flinders Island, Tas**
6.8	May 10, 1897	Offshore Beachport, SA
6.8	Oct 14, 1968	Meckering, WA
6.8	May 6, 1978	North of Lake Tobin, WA
6.7	**Aug 16, 1929**	**Offshore Broome, WA**
6.7	**Mar 24, 1970**	**Tobin Lake, WA**
6.7 6.5 6.3 (a)	**Jan 22, 1988**	**Tennant Creek, NT**
6.6	**Jan 05, 1885**	**Offshore Geraldton, WA**
6.5	Jan 05, 1875	Geraldton, WA

6.5	Oct 28, 1937	Simpson Desert, NT
6.5	**Jun 27, 1941**	**Simpson Desert, NT**
6.4	**Jul 13, 1884**	**Offshore Flinders Island, Tas**
6.4	**Sep 19, 1884**	**Offshore Flinders Island, Tas**
6.4	**Mar 25, 1970**	**Lake Tobin, WA**
6.4	Jul 16, 1971	Tobin Lake, WA
6.3	Mar 23, 1964	Derby, WA
6.3	Aug 10, 1997	Collier Bay, WA
6.2	**Dec 15, 1873**	**Central Australia, WA**
6.2	Sep 15, 1946	Offshore Flinders Island, Tas
6.2	Aug 28, 1972	Simpson Desert, NT
6.2	Oct 03, 1975	Tobin Lake, WA
6.2	Feb 19, 1976	North of Exmouth, WA
6.2	**Jun 02, 1979**	**Cadoux, WA**
6.0	**Sep 19, 1902**	**Warroka, SA**
6.0	Jan 13, 1910	Tasman Sea
6.0	Jun 07, 1918	Bundaberg, Qld
6.0	Nov 25, 1983	Tasman Sea
5.9	Aug 28, 1883	Gayndah, Qld
5.9	Nov 27, 1959	Kimberley, WA
5.9	May 19, 1965	Carnarvon, WA
5.9	Nov 13, 1966	WA
5.9	**Mar 10, 1970**	**Calingiri, WA**
5.9	Jun 18, 1973	WA
5.9	**Mar 30, 1986**	**Marryat Creek, SA**

(a) Three quakes occurred on this date, but were treated as one event.
Offshore quakes were included if they happened relatively near the coastline.
Quakes in **bold** appeared in the year beginning July 1 of those years in **Table 2**.
Source: University of Western Australia

Appendix 5
MAJOR NEW ZEALAND QUAKES 1840-2010
M => 6.8

Date	M	Location
Jan 23, 1855	**8.1**	**Wairarapa**
Jun 17, 1929	**7.8**	**Murchison**
Feb 02, 1931	**7.8**	**Hawke's Bay**
Jul 15, 2009	7.8	Dusky Sound
Mar 5, 1934	7.6	Pahiatua
Oct 16, 1848	**7.5**	**Marlborough**
Feb 23, 1863	7.5	Hawke's Bay
Oct 19, 1868	**7.5**	**Cape Farwell**
Sep 01, 1888	7.3	North Canterbury
Sep 30, 2007	**7.3**	**Auckland Islands**
Feb 13, 1931	**7.3**	**Hawke's Bay**
Jun 24, 1942	**7.2**	**Wairarapa**
Nov 23, 2004	7.2	Puysegur Trench
Mar 9, 1929	**7.1**	**Arthur's Pass**
May 24, 1968	7.1	Inangahua

Aug 22, 2003	7.1	Fiordland
Sep 04, 2010	7.1	Darfield (Christchurch)
Aug 02, 1942	**7.0**	**Wairarapa**
Feb 06, 1995	7.0	East Cape
Feb 12, 1893	**6.9**	**Nelson**
Dec 20, 2007	**6.8**	**Gisborne**

Earthquakes in **bold** occurred in the year beginning January 1 of those years in the **Table 3**.
Source of Raw Data: GNS Science.

Appendix 6
MAJOR QUAKES IN SOUTH EAST FRANCE 1750-2000

ALPES DU NORD

Savoie

11/03/1817	**Mont-Blanc**	**VII**
19/02/1822	**Chautagne**	**VIII**
11/08/1839	**Annecy**	**VII**
08/10/1877	**Faucigny**	**VII**
30/12/1879	Chablais	VII
22/07/1881	Belledonne	VII
29/04/1905	Aig.-Rouges	VIII
13/08/1905	Glac. du Tour	VII
17/04/1936	Vuache	VII
30/03/1958	**Chautagne**	**VII**
19/08/1968	Chablais	VII
15/07/1996	**Annecy**	**VII-VIII**

Dauphiné

25/04/1962	Vercors	VII-VIII
25/04/1963	Vercors	VII
27/04/1963	Vercors	VII

Sud-ouest de la Suisse

19/09/1754	**Lac Léman**	**VII**
09/12/1755	Valais	VIII
24/01/1837	Valais	VII
25/07/1855	**Valais**	**VIII-IX**
26/07/1855	**Valais**	**VIII**
26/07/1855	**Valais**	**VII-VIII**
28/10/1855	**Valais**	**VII**
01/12/1874	Valais	VII
04/07/1880	Valais	VII
25/11/1881	Lac Léman	VII
25/08/1915	Valais	VII
15/04/1924	**Valais**	**VII**
25/01/1946	Valais	VIII
30/05/1946	Valais	VII
19/05/1954	Valais	VII

ALPES DU SUD

Provence

18/11/1769	Comtat	VII
21/12/1769	Venaissin	VII
20/03/1812	**Durance**	**VII-VIII**
26/03/1812	**Durance**	**VII**
12/12/1855	**Haut-Verdon**	**VIII**
09/06/1863	Région de Digne	VII
19/05/1866	**Durance**	**VII**
10/04/1905	Ventoux	VII
11/06/1909	Trévaresse	IX
14/05/1913	**Durance**	**VII-VIII**
24/07/1927	Ventoux	VII
30/11/1951	**Haut-Verdon**	**VIII**
08/06/1952	Ventoux	VII

ITALIE

Ligurie

23/02/1818	**Ligurie**	**VIII**
26/05/1831	Ligurie	VIII-IX
29/12/1854	Ligurie	VII-VIII
23/02/1887	**Ligurie**	**X**

Piémont

09/03/1753	Val Chisone	VII
26/05/1767	Lanzo	VIII
02/04/1808	**Val Pellice**	**VIII**
02/04/1808	**Val Pellice**	**VII**
16/04/1808	**Val Pellice**	**VII**
25/10/1858	Val Chisone	VII
17/02/1947	Val Chisone	VIII
05/01/1980	Pinerolo	VII

COULOIR RHODANIEN

23/01/1773	**Tricastin**	**VII-VIII**
14/07/1873	**Tricastin**	**VII**
19/07/1873	**Tricastin**	**VII-VIII**
08/08/1873	**Tricastin**	**VII-VIII**
13/05/1901	Drôme	VII
12/05/1934	Tricastin	VII

Queyras et Ubaye **27/11/1884 Queyras VII** **12/07/1904 Queyras VII** 19/03/1935 Embrunais VIII 18/07/1938 Queyras VII 05/04/1959 Haute-Ubaye VIII Vesubie none	30/09/1946 Cévennes VII **CORSE** 22/10/1775 Corse occidentale VII
The years in **bold** experienced major earthquakes in the year commencing March 1 of those years in **Appendix 7**. Information given – Date, Region and Intensity. **Source**: SISMALP - French Alps Seismic Network.	

Appendix 7 **9/56 YEAR CYCLE:** **QUAKES IN SOUTH EAST FRANCE 1750-2000** **Year beginning March 1**						
Sq 52	Sq 05	Sq 14	Sq 23	Sq 32	Sq 41	Sq 50
						1754 **Sep19**
1756	1765	1774	1783	1792	1801	1810
1812 **Mar20** **Mar26**	**1821** **1822** **Feb19**	1830	**1839** **Aug11**	1848	1857	**1866** **May19**
1868	**1877** **Oct08**	1886 **1887** **Feb23**	1895	**1904** **Jul12**	**1913** **May14**	1922
1924 **Apr15**	1933	1942	**1951** **Nov30**	1960	1969	1978
1980	1989	1998	2007	2016		
Sq 03	Sq 12	Sq 21	Sq 30	Sq 39	Sq 48	Sq 01
					1752	1761
1763	1772 **1773** **Jan23**	1781	1790	1799	**1808** **Apr02** **Apr02** **Apr16**	**1817** **Mar11** **1818** **Feb23**
1819	1828	1837	1846	**1855** **Jul25** **Jul26** **Jul26** **Oct28** **Dec12**	1864	**1873** **Jul14** **Jul19**
1875	**1884** **Nov27**	1893	1902	1911	1920	1929
1931	1940	1949	**1958** **Mar30**	1967	1976	1985
1987	**1996** **Jul15**	2005				

Each 56 year sequence is separated by an interval of 9 years.
Years in **bold** contain major earthquakes in the French south east in the year beginning March 1.
Source of Earthquake Data: SISMALP - French Alps Seismic Network

Appendix 8
MAJOR ICELANDIC EARTHQUAKES 1706-2000 M =>6.0

Date/Time	Lat/Long	M	Depth	Location
1706-04-20 09:00	**64.0 -21.2**	**6.0**	**0 km**	**V af Hveragerði**
1724-08-09 00:00	**63.9 -21.5**	**6.0**	**7 km**	**NV af Þorlákshöfn**
1732-09-07 06:00	64.0 -20.1	6.7	8 km	ASA af Árnesi
1734-03-21 00:00	63.9 -20.8	6.8	8 km	VSV af Þjórsárbrú
1766-04-05 09:00	**64.0 -19.9**	**6.0**	**11 km**	**V af Heklu**
1766-09-09 19:00	**64.0 -21.1**	**6.0**	**4 km**	**A af Hveragerði**
1784-08-14 16:35	**64.0 -20.5**	**7.1**	**10 km**	**NA af Þjórsárbrú**
1784-08-16 15:13	**63.9 -20.9**	**6.7**	**7 km**	**SA af Selfossi**
1829-02-02 21:45	**63.9 -20.0**	**6.0**	**19 km**	**VSV af Heklu**
1872-04-18 10:00	**66.0 -17.5**	**6.3**	**8 km**	**VSV af Húsavík**
1872-04-18 11:00	**66.2 -17.9**	**6.3**	**4 km**	**NV af Flatey**
1885-01-25 10:50	**66.1 -16.9**	**6.3**	**20 km**	**VNV af Ásbyrgi**
1896-08-26 21:50	**64.0 -20.2**	**6.9**	**5 km**	**SSA af Árnesi**
1896-08-27 09:30	**64.0 -20.1**	**6.7**	**8 km**	**ASA af Árnesi**
1896-09-05 23:30	**63.9 -21.0**	**6.0**	**4 km**	**S af Selfossi**
1896-09-05 23:35	**64.0 -20.6**	**6.5**	**8 km**	**NNA af Þjórsárbrú**
1896-09-06 02:00	**63.9 -21.2**	**6.0**	**9 km**	**ANA af Þorlákshöfn**
1910-01-22 07:48	**66.5 -17.0**	**7.1**	**32 km**	**NV af Kópaskeri**
1912-05-06 18:00	**63.9 -20.0**	**7.0**	**19 km**	**VSV af Heklu**
1929-07-23 18:43	63.9 -21.7	6.2	9 km	SSV af Bláfjallaskála
1934-06-02 13:43	**66.0 -18.5**	**6.2**	**3 km**	**NNA af Dalvík**
1963-03-28 00:16	66.3 -19.6	7.0	30 km	NA af Hrauni_á Skaga
1976-01-13 13:29	**66.2 -16.6**	**6.2**	**13 km**	**SSV af Kópaskeri**
2000-06-17 15:44	64.0 - 20.4	6.4	6 km	
2000-06-21 00:51	64.0 - 20.7	6.1	5 km	

Years in **bold** experienced a major earthquake (M => 6.0) in the 8 months commencing January 15 as shown in **Appendix 9**.
Source: Icelandic Meteorological Office.

Appendix 9
9/56 YEAR CYCLE: ICELANDIC QUAKES 1760–2010 M => 6.0
Year beginning January 20

Sq 35	Sq 44	Sq 53	Sq 06	Sq 15	Sq 24	Sq 33	Sq 42	Sq 51	Sq 04	Sq 13
									1708	1717
		1701	1710	1719	1728	1737	1746	1755	1764	1773
1739	1748	1757	**1766** **0405** **0809**	1775	**1784** **0814** **0816**	1793	1802	1811	1820	**1829** **0202**
1795	1804	1813	1822	1831	1840	1849	1858	1867	1876	**1885** **0125**

1851	1860	1869	1878	1887	**1896 0826 0827 0905 0905 0906**	1905	1914	1923	1932	1941
1907	1916	1925	**1934 0602**	1943	1952	1961	1970	1979	1988	1997
1963 0328	1972	1981	1990	1999	2008					
Sq 22	Sq 31	Sq 40	Sq 49	Sq 02	Sq 11	Sq 20	Sq 29	Sq 38	Sq 47	Sq 56
				1706 0420	1715	**1724 0809**	1733	1742	1751	1760
1726	1735	1744	1753	1762	1771	1780	1789	1798	1807	1816
1782	1791	1800	1809	1818	1827	1836	1845	1854	1863	**1872 0418 0418**
1838	1847	1856	1865	1874	1883	1892	1901	**1910 0222**	1919	1928
1894	1903	**1912 0506**	1921	1930	1939	1948	1957	1966	1975 **1976 0113**	1984
1950	1959	1968	1977	1986	1995	2004				
2006										
Years in **bold** contained major Icelandic earthquakes in the year beginning January 20. **Source of Earthquake Data**: Icelandic Meteorological Office.										

Appendix 10
EARTHQUAKE HISTORY OF INDIA SINCE 1850

DATE	LOCATION	M
2004 Dec 26	Offshore Sumatra	9.3
1897 Jun 12	Shillong Plateau	8.7
1950 Aug 15	**Arunachal Pradesh-China border**	**8.5**
1934 Jan 15	**Bihar-Nepal border**	**8.3**
1941 Jun 26	**Andaman Islands**	**8.1**
1819 Jun 16	Kuthch, Gujarat	8.0
1905 Apr 04	**Kangra H P**	**8.0**
2001 Jun 26	Bhuj, Gujarat	7.7
1918 Jul 08	Srimangal, Assam	7.6
2005 Oct 08	**Pakistan**	**7.6**
1869 Jan 10	**Near Cachar, Assam**	**7.5**
1943 Oct 23	Assam	7.2
1930 Jul 02	**Dhubri, Assam**	**7.1**
1885 May 30	**Sopor, J&K**	**7.0**
1956 Jul 21	Anjar, Gujarat	7.0
1999 Mar 29	**Chamoli District UP**	**6.8**
1988 Aug 06	**Manipur-Myanmar Border**	**6.6**
1991 Oct 20	Uttarkashi, UP Hills	6.6

1967 Dec 10	**Koyna, Maharashtra**	**6.5**
1988 Aug 21	**Bihar-Nepal border**	**6.4**
1993 Sep 30	Latur-Osmanabad, Maharashtra	6.3
1975 Jan 19	Kinnaur, HP	6.2
1997 May 22	**Jabalpur, MP**	**6.0**
Events highlighted in **bold** fall in the years ended August 30 in **Table 6.** Source: Earthquake History of India		

Appendix 11 LISTING OF ITALIAN QUAKES BY INGV 1750–2010					
M => 6.3			**M => 6.0 to =< 6.2**		
Date	**M**	**Location**	**Date**	**M**	**Location**
Jul 27, 1751	6.3	Gualdotadino	Jun 03, 1781	6.2	Cagliese
Feb 05, 1783	6.9	Calabria	Mar 10, 1786	6.0	Northern Sicily
Feb 07, 1783	6.6	Calabria	Apr 20, 1796	6.0	Buchs
Mar 28, 1783	6.9	Calabria	Feb 20, 1818	6.0	Catanese
Jul 26, 1805	6.6	Molise	Apr 25, 1836	6.2	Calabria
Mar 08, 1832	6.5	Crotonese	Feb 12, 1854	6.2	Cosentino
Aug 14, 1851	6.3	Basilicata	Oct 04, 1870	6.2	Cosentino
Dec 16, 1857	7.0	Naples	Dec 06, 1875	6.1	San Marco
Jun 29, 1873	6.3	Bellunese	Nov 16, 1894	6.1	Calabria
Feb 23, 1887	6.3	Liguria	Jun 29, 1919	6.2	Mugello
Apr 14, 1895	6.3	Slovenia	Jan 25, 1946	6.1	Vallese
Sep 08, 1905	7.1	Calabria	Aug 21, 1962	6.2	Irpinia
Dec 28, 1908	7.2	Messina	Jan 15, 1968	6.1	Western Sicily
Jan 13, 1915	7.0	Avezzano	Apr 15, 1978	6.1	Golfo di Patti
Sep 07, 1920	6.5	Garfagnana	Sep 26, 1997	6.1	Umbria
Jul 23, 1930	6.7	Irpinia	Sep 06, 2002	6.0	Southern Italy
May 06, 1976	6.5	Fruili			
Nov 23, 1980	6.9	Southern Italy			
Apr 06, 2009	6.3	L'Aquila			
Source of Raw Data: Instituto Nazionale di Geofisica e Vulcanologia. Catalogo Parametrico dei Terremoti Italiani. CPT104 http://emidius.mi.ingv.it/cpt104/					

Appendix 12 9/56 YEAR CYCLE: ITALIAN QUAKES 1750-2010 M => 6.0 Year beginning January 1									
Sq 10	Sq 19	Sq 28	Sq 37	Sq 46	Sq 55	Sq 08	Sq 17	Sq 26	Sq 35
				1750	1759	1768	1777	**1786 Mar10**	1795
1770	1779	1788	1797	1806	1815	1824	1833	1842	1851
1826	1835	1844	1853	1862	1871	1880	1889	1898	1907
1882	1891	1900	1909	1918	1927	1936	1945	1954	1963
1938	1947	1956	1965	1974	1983	1992	2001	2010	
1994	2003	2012							
Sq 44	Sq 53	Sq 06	Sq 15	Sq 24	Sq 33	Sq 42	Sq 51	Sq 04	

							1755	1764	
	1757	1766	1775	1784	1793	1802	1811	1820	
1804	1813	1822	1831	1840	1849	1858	1867	1876	
1860	1869	1878	**1887 Feb23**	1896	**1905 Sep08**	1914	1923	1932	
1916	1925	1934	1943	1952	1961	1970	1979	1988	
1972	1981	1990	1999	2008	2017				

Earthquakes within this table have been highlighted in **bold**.
Source of Earthquake Data: Instituto Nazionale di Geofisica e Vulcanologia. Catalogo Parametrico dei Terremoti Italiani. CPT104 http://emidius.mi.ingv.it/cpt104/

Appendix 13
TAIWANESE EARTHQUAKES 1900-2004 M => 7.0

DDMMYYYY	UTC	Long	Lat	M
15-05-1900	12:10	120.50	21.50	7.0
16-03-1906	22:43	120.45	23.55	7.1
11-01-1908	03:35	121.40	23.70	7.3
14-04-1909	19:54	121.50	25.00	7.3
21-11-1909	07:36	121.80	24.40	7.3
12-04-1910	00:22	122.90	25.10	7.8
17-06-1910	05:28	121.00	21.00	7.0
01-09-1910	00:45	121.70	22.70	7.0
01-09-1910	14:21	122.40	24.10	7.1
04-07-1917	00:38	123.00	25.00	7.7
04-07-1917	05:36	123.00	25.00	7.2
20-12-1919	20:37	121.70	22.80	7.0
05-06-1920	04:21	122.00	24.00	8.0
01-09-1922	19:16	122.20	24.60	7.6
14-09-1922	19:31	122.30	24.60	7.2
20-04-1935	22:01	120.82	24.35	7.1
04-09-1935	01:37	121.55	22.50	7.2
22-08-1936	06:51	121.20	22.00	7.3
08-12-1937	08:32	121.40	23.10	7.0
07-09-1938	04:03	121.80	23.80	7.0
06-12-1938	23:00	121.60	22.90	7.0
16-12-1941	19:19	120.47	23.40	7.1
26-09-1947	16:01	123.00	24.80	7.2
21-10-1951	21:34	121.72	23.88	7.3
22-10-1951	03:29	121.72	24.08	7.1
22-10-1951	05:43	121.95	23.83	7.1
24-11-1951	18:50	121.35	23.27	7.3
23-02-1957	20:26	121.80	23.80	7.1
26-04-1959	20:40	122.50	25.00	7.5
15-08-1959	08:57	121.30	21.70	7.1
13-02-1963	08:50	122.10	24.40	7.4
12-03-1966	16:31	122.67	24.24	7.8
26-02-1968	10:50	121.50	22.70	7.1
25-01-1972	02:06	122.26	22.45	7.5
25-01-1972	03:41	122.15	23.03	7.0
23-12-1978	11:23	122.00	23.30	7.0

05-09-1996	23:42	121.37	22.00	7.0
20-09-1999	17:47	120.82	23.85	7.3
15-10-2004	04:08	122.85	24.46	7.1
Source: The Central Weather Bureau of Taiwan (pers com).				

Appendix 14
9/56 YEAR CYCLE: TAIWANESE QUAKES 1900–2004 M => 7.0
Year beginning March 1

Sq 46	Sq 55	Sq 08	Sq 17	Sq 26	Sq 35	Sq 44	Sq 53	Sq 06	Sq 15	Sq 24	Sq 33
											1905
					1907 **1908** **0111**	1916	1925	1934	1943	1952	1961
1918	1927	**1936** **0822**	1945	1954	1963	1972	1981	1990	**1999** **0920**	2008	2017
1974	1983	1992	2001								
Sq 42	Sq 51	Sq 04	Sq 13	Sq 22	Sq 31	Sq 40	Sq 49	Sq 02	Sq 11	Sq 20	Sq 29
											1901
					1903	1912	1921	1930	1939	1948	1957
1914	1923	1932	**1941** **1216**	1950	**1959** **0426** **0815**	1968	1977	1986	1995	**2004** **1015**	2013
1970	1979	1988	1997	2006							

Dates expressed as YYYYMMDD.
The 56 year sequences in the table are separated by an interval of 9 years.
Taiwanese earthquakes in **bold** occurred in the year commencing March 1.
Source of Earthquake Data: The Central Weather Bureau of Taiwan (pers com).

Appendix 15
ALASKAN EARTHQUAKES 1898-2010 M => 7.5
US Geological Survey

Date	M	Location
1964 Mar 28	**9.2**	**Prince William Sound**
1965 Feb 04	8.7	Rat Islands
1957 Mar 09	**8.6**	**Andreanof Islands**
1938 Nov 10	**8.2**	**East of Shumagin Islands**
1946 Apr 01	**8.1**	**Unimak Island**
1899 Sep 10	**8.0**	**Yakutat Bay**
1986 May 07	**8.0**	**Andreanof Islands**
1899 Sep 04	**7.9**	**Near Cape Yakataga**
1917 May 31	**7.9**	**Shumagin Islands**
1987 Nov 30	7.9	Gulf of Alaska
1996 Jun 10	7.9	Andreanof Islands
2002 Nov 03	**7.9**	**Central Alaska**
1906 Aug 17	7.8	Rat Islands
1929 Mar 07	7.8	Fox Islands
1929 Dec 17	**7.8**	**Near Islands**
1988 Mar 06	7.8	Gulf of Alaska

2003 Nov 17	**7.8**	**Rat Islands**
1900 Oct 09	7.7	Kodiak Island
1916 Feb 06	7.7	South of Rat Islands
1958 Jul 10	7.7	Lituya Bay
1898 Jun 29	7.6	Near Islands
1972 Jul 30	7.6	Sitka
1975 Feb 02	**7.6**	**Near Islands**
1948 May 14	7.5	Alaska Peninsula
1979 Feb 28	7.5	Mt. St. Elias
Events in **bold** occurred in the year ended November 5 of those years in **Table 7**. **Source of Raw Data**: US Geological Survey. Earthquakes in the United States. Magnitude 7.0 and Greater. http://earthquake.usgs.gov/earthquakes/states/large_usa_7.php		

Appendix 16
CHILEAN, ALASKAN & HAWAIIAN QUAKES CAUSING TSUNAMIS ON HAWAII
1800-2010 (run up => 1 metre)

Year	Month	Day	M	Source of Tsunami	Table/Append
Chile					
1819	4	12	8.5	Northern Chile	Table 1
1835	2	20	8.2	Central Chile	-
1837	11	7	8.5	Southern Chile	Table 1
1868	8	13	8.5	Northern Chile	Table 1
1877	5	10	8.3	Northern Chile	Table 1
1906	8	17	8.2	Central Chile	Table 1
1922	11	11	8.5	Northern Chile	Table 1
1943	4	6	8.2	Central Chile	Table 1
1955	4	19	7.1	Central Chile	-
1960	5	22	9.5	Central Chile	Table 1
1985	3	3	8.0	Central Chile	-
1995	7	30	8.0	Northern Chile	-
2010	2	27	8.8	Offshore southern Chile	Table 1
Alaska					
1854	1	27	*	Kodiak Island	Table 7
1872	8	23	*	Fox Islands, Aleutian Islands	Table 7
1878	1	20	*	Aleutian Islands	-
1929	3	7	7.8	Fox Islands, Aleutian Islands	-
1946	4	1	8.1	Unimak Island	Table 7
1957	3	9	8.6	Andreanof Islands	Table 7
1958	7	10	8.3	South east Alaska	-
1964	3	28	9.2	Prince William Sound	Table 7
1965	2	4	8.7	Rat Islands, Aleutian Islands	-
Hawaiian Islands					
1868	4	3	7.9	Hawaii	Table 12
1869	7	24	*	Offshore northern Oahu	-
1903	11	29		Hawaii	Table 12
1908	9	21	6.8	Hawaii	-
1919	10	2		Hawaii	Table 12
1924	5	30		Hawaii	Table 12

1926	3	20	*	Hawaii	-
1951	8	21	6.9	Hawaii	-
1952	3	17	4.5	Hawaii	-
1975	11	29	7.1	Hawaii	Table 12
Source of Raw Data: National Geophysical Data Center. Search parameters. Tsunami run up. region: Hawaii. Water Height: => 1 metre. http://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=167&d=166					

Appendix 17
MAJOR TSUNAMIS ON THE ISLAND OF HAWAII: 1810-1975

Date	Source	Tsunami Mag
Apr 12, 1819	**Chile**	**2.0**
Nov 07, 1835	Chile	4.0
Nov 07, 1837	Chile	3.0
May 17, 1841	Kamchatka	2.0
Apr 03, 1868	**Hawaii**	**4.1**
Aug 13, 1868	**Chile**	**4.3**
Oct 02, 1868	**South Pacific**	**na**
Jul 24, 1869	South Pacific	na
May 10, 1877	**Chile**	**4.0**
Jan 20, 1878	**Aleutian Is (?)**	**na**
Jun 15, 1896	Japan	4.0
Aug 09, 1901	Tonga	na
Jan 31, 1906	Columbia/Ecuador	1.0
Aug 17, 1906	**Chile**	**2.0**
Sep 07, 1918	Kuriles	3.6
Oct 02, 1919	Hawaii	Height - 14 ft
Nov 11, 1922	Chile	3.0
Feb 03, 1923	Kamchatka	3.0
Mar 02, 1933	**Japan**	**3.0**
Apr 01, 1946	Aleutian Is	5.0
Mar 17, 1952	Hawaii	Height - 10 ft
Nov 04, 1952	Kamchatka	4.0
Mar 09, 1957	Aleutian Is	3.5
May 22, 1960	**Chile**	**4.5**
Mar 28, 1964	Alaska	4.5
Nov 29, 1975	Hawaii	Height - 47 ft

Includes large tsunamis (run up > 1.0 m) with reported damage on the island of Hawaii.
Tsunami events in **bold** fall in the year beginning March 1 of those years in **Table 11**.
Source: After Lander & Lockridge (1989).

Appendix 18
BEGINNING OF KILAUEA ERUPTIONS SINCE 1820

Year	Start	Vol (km3)	Year	Start	Vol (km3)
1983	Jan 03	1.9	1955	Feb 28	0.0876
1982	Sep 25	0.003	1954	May 31	0.0062
1982	Apr 30	0.0005	1952	Jun 27	0.0467
1979	**Nov 16**	**0.00058**	1934	Sep 06	0.0069
1977	**Sep 13**	**0.0329**	1931	Dec 23	0.007
1975	**Nov 29**	**0.00022**	**1930**	**Nov 19**	**0.0062**
1974	Dec 31	0.0143	**1929**	**Jul 25**	**0.0026**
1974	Sep 19	0.0102	**1929**	**Feb 20**	**0.0014**
1974	Jul 19	0.0066	1927	Jul 07	0.0023
1973	Nov 10	0.0027	**1924**	**Jul 19**	**0.000234**
1973	May 05	0.0012	**1924**	**May 10**	**No lava**
1972	Feb 03	0.162	**1923**	**Aug 25 ?**	**0.000073**
1971	Sep 24	0.0077	1922	May 28	?
1971	Aug 14	0.0091	1921	Mar 18	0.0064
1969	**May 24**	**0.185**	**1919**	**Dec 21**	**0.0453**
1969	**Feb 22**	**0.0161**	1919	Feb 07	0.0252 ?
1968	**Oct 07**	**0.0066**	1918	Feb 23	0.000183
1968	**Aug 22**	**0.00013**	1894	Jul 07	?
1967	Nov 05	0.0803	1894	Mar 21	?
1965	Dec 24	0.00085	1885	Mar	?
1965	Mar 05	0.0168	**1884**	**Jan 22**	**?**
1963	Oct 05	0.0066	**1877**	**May 21 ?**	**?**
1963	Aug 21	0.0008	**1877**	**May 04**	**?**
1962	Dec 07	0.00031	**1868**	**Apr 02 ?**	**0.000183**
1961	Sep 22	0.0022	**1868**	**Apr 02**	**?**
1961	Jul 10	0.0126	1840	May 30	0.205
1961	Mar 03	0.00026	1832	Jan 14	?
1961	Feb 24	0.000022	1823	Feb Jul	0.0110
1960	**Jan 13**	**0.1132**			
1959	**Nov 14**	**0.0372**			

Eruptions in **bold** appeared in 9/56 year cycle in **Table 13**.
Source: US Geological Survey.
Summary of Historical Eruptions, 1750 – Present.
http://hvo.wr.usgs.gov/kilauea/history/historytable.html

Appendix 19
BEGINNINGS OF MAUNA LOA ERUPTIONS SINCE 1840
Year ended July 31

Year	Start	Vol (km^3)	Year	Start	Vol (km^3)
1984	Mar 26	0.220	**1892**	**Nov 30**	**0.012**
1975	Jul 5	0.030	1887	Jan 16	0.128
1950	Jun 1	0.376	1880	Nov 5	0.130
1949	**Jan 6**	**0.116**	1880	May 1	0.130
1942	**Apr 26**	**0.176**	1879	Mar 9	0.001
1940	**Apr 17**	**0.110**	1877	Feb 14	0.008
1935	Nov 21	0.087	**1872**	**Aug 9**	**0.630**
1933	Dec 2	0.100	1871	Aug 10	0.020

1926	Apr 10	0.121	**1868**	**Mar 27**	**0.123**
1919	**Sep 26**	**0.183**	**1865**	**Dec 30**	**0.050**
1916	May 19	0.031	1859	Jan 23	0.383
1914	Nov 25	0.055	1855	Aug 8	0.280
1907	Jan 9	0.121	1852	Feb 17	0.182
1903	**Oct 6**	**0.070**	1851	Aug 8	0.035
1903	**Sep 1**	**0.003**	1849	May ?	0.025
1899	Jul 1	0.081	1843	Jan 10	0.202
1896	Apr 21	0.025			

Eruptions in bold commenced in the 9/56 year grid as given in **Table 13**.
Source: US Geological Survey. Summary of Historical Eruptions, 1843 – Present. http://hvo.wr.usgs.gov/maunaloa/history/historytable.html

Appendix 20
36/56 YEAR CYCLES: HAWAIIAN ERUPTIONS 1820 – 2010
Year ending July 31

Grid 1						
Sq 05		Sq 41		Sq 21		Sq 01
				1837	+ 36	**1873** **#**
		1857	+ 36	**1893** **#**	+ 36	**1929** ******
1877 ****#**	+ 36	1913	+ 36	**1949** **#**	+ 36	1985
1933	+ 36	**1969** ********	+ 36	2005		
1989		2005				
Grid 2						
Sq 52		Sq 32		Sq 12		Sq 48
				1828	+ 36	1864
		1848	+ 36	**1884** *****	+ 36	**1920** ***#**
1868 ****#**	+ 36	**1904** **##**	+ 36	**1940** **#**	+ 36	**1976** *****
1924 *******	+ 36	**1960** ******	+ 36	1996		
1980 *****						

* Denoted the beginning of an eruption at Kilauea.
\# Denotes the beginning of an eruption at Mauna Lao.
Years presented in bold contained eruptive beginnings in the year ending July 31.
Source of Raw Data: US Geological Survey.

Appendix 21

FINANCIAL GRIDS

The author was hoping to discover seismic grids, similar to those established for key financial events. A few seismic grids could be produced, but none were very exact. In contrast, precise financial grids do arise, with a few examples presented for interest. NB: The annual one day (AOD) rise or fall is taken as the biggest % one day movement in the Dow Jones Industrial Average index (DJIA) in the year commencing March 1.

The 2-8/60 year Grid

Some 6 DJIA AOD falls (=> -3.60%) took place in October between 1910 and 2000, which formed a very neat grid based on intervals of 2, 8 and 60 years (see Table A). The 6 events occurred before the full Moon or before the new Moon, producing a precise pattern that would be very unlikely to occur by chance. The DJIA AOD rises in 1929, 1937, 1987, 1989 and 1997 all happened a few days after the corresponding AOD fall. The anomaly occurred with the 1927 AOD rise on September 6 (+2.95%).

Table A
THE 2-8/60 YEAR GRID: INTERVALS & LUNAR PHASE

October AOD Falls 1910 - 2005				
1927 Oct 08 -3.65% 150 A°	+ 2 yrs	1929 Oct 28 -12.83% 313 A°	+ 8 yrs	1937 Oct 18 -7.75% 164 A°
+ 60 yrs		+ 60 yrs		+ 60 yrs
1987 Oct 19 -22.61% 324 A°	+ 2 yrs	1989 Oct 13 -6.91% 164 A°	+ 8 yrs	1997 Oct 27 -7.18% 320 A°

Source: McMinn, 2010a.

The grid in Table A may be extended on the right hand side by adding 11 years. This gave the October 15, 2008 AOD fall (-7.75%) during Black October. Subtracting 60 years from this date gave the November 3, 1948 AOD fall (-3.85%), when Truman's surprise victory in the presidential elections precipitated stock market tremors.

The 1929 – 1987 Parallels

The 1929 and 1987 were the biggest stock market panics in US financial history. Remarkable parallelism was produced between the record highs, the AOD rises/falls and major post crash one day falls (see Table B). Each of these events was separated by an interval of 717.0 lunar months.

Table B
THE 1929 & 1987 PANICS: PARALLELISM & LUNAR PHASE

Record High		AOD Fall		AOD Rise		Major Fall (a)
1929 Sep 3 003 A°	+55 Days	1929 Oct 28 -12.83% 313 A°	+2 Days	1929 Oct 30 +12.34% 338 A°	+7 Days	1929 Nov 6 -9.92% 058 A°
+717.05 Lunar Months		+717.05 Lunar Months		+717.05 Lunar Months		+716.99 Lunar Months
1987 Aug 25 013 A°	+55 Days	1987 Oct 19 -22.61% 324 A°	+2 Days	1987 Oct 21 +10.17% 347 A°	+5 Days	1987 Oct 26 -8.04% 051 A°

(a) Major one day falls were recorded after the panics: -9.92% on Nov 6, 1929 and -8.04% on Oct 26, 1987. These were among the 10 biggest one day falls ever recorded for the DJIA. The 29.53 day Lunar Month is the time taken for the Moon to complete one cycle New Moon to New Moon.
Abbreviations: Annual one day (AOD) movement is the biggest DJIA one day % rise or fall in the year commencing March 1.
Sources: Carolan, 1998; McMinn, 2004.

The Crises of 1987, 1997 and 2007
Intervals for the highs and lows of 1987, 1997 and 2007 financial crises were quite remarkable and have been presented in **Table C**.

Table C
INTERVALS FOR THE PEAKS/TROUGHS OF THE 1987, 1997 & 2007 CRISES

DJIA Event	Interval Days	DJIA Event	Interval Days	DJIA Event
Spring High Apr 06, 1987	3704	Spring High May 27, 1997	3705	Summer High Jul 19, 2007
Spring Low May 20, 1987	3614	Spring Low Apr 11, 1997	3615	Spring Low Mar 05, 2007
Summer High* Aug 25, 1987	3634	Summer High* Aug 06, 1997	3634	Summer High Jul 19, 2007
Autumn High Oct 02, 1987	3658	Autumn High Oct 07, 1997	3654	Autumn High* Oct 09, 2007

* DJIA record high.

LUNAR AND SOLAR PERIODS IN EARTHQUAKES AND VOLCANISM: A REVIEW OF THE LITERATURE

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Abstract: For decades there have been strong correlations between seismic eruptions and the positions of the earth, moon and sun as well as the level of solar activity. While a few of the weaker correlations can be incorporated into the standard theories, the stronger and more predominate relationships have no explanation within accepted theories of gravity and/or geology. There are about 200 references here which show a positive correlation between seismic activity and solar position, lunar position, and solar activity. Over half of them are incompatible with plate tectonics.

The author has previously explained these relationships in terms of an earth expansion model (Kokus 1993, 1998, 2001 and 2011). Here, my intent is to make this literature available to a greater audience. Much of it was published in obscure journals, some of which no longer exist. Very little of it is online or shows up in a google search. Many current researchers are rediscovering phenomena which was originally discovered 80 years ago.

Keywords: *Tidal triggering, lunar triggering, solar triggering, seismic cycles, earthquake cycles, earthquake prediction*

Introduction. Throughout history, mankind has sought order in the apparent randomness of earthquakes and volcanic eruptions. It was only natural to look for correlations with periods belonging to the sun and moon. Many researchers have independently come up with similar patterns. Some of these patterns have been explained with models where ocean or earth tides provided an additional "nudge" to plates that were moving in accordance with the accepted theory (continental drift) resulting in an earthquake. But even with this, there is quite often a problem. The researchers often find it necessary to add a "phase" to the peak tides in order to obtain a causal relationship. This phase frequently has an unrealistic interpretation, such as the earthquakes preceding the peak tidal stress by over three days.

The predominate pattern suggests a tectonic model where plate motions would not be triggered by the local tidal stress, but by the effects that the tides have on the moments of inertia of the various plates and by their effects on the Earth rotation as a whole or on the total surface area of the earth.

Earthquake patterns. In the standard theories, earthquakes and volcanic eruptions are treated as random occurrences. Most researchers in seismic prediction assume that any non-randomness would be a small variation brought about by tides. They are usually surprised by the depth and self-consistency of the literature on a subject that they have ignored. There are strong relationships between Earth, solar and lunar positions; solar activity; and seismic activity, most of which cannot be explained by local tidal stresses. These relationships are referred to as signatures by Bagby (1960-1975) or cosmolocations by Tamrazyan (1957-1993). What follows is an attempt to describe the signature archetypes.

The nature of tides. When the Earth rotates about the sun, centrifugal force and gravity are perfectly balanced at the center of the earth. On the side away from the sun, the sun's gravity is weaker and the centrifugal force is stronger; therefore, there is a bulge. On the side toward the sun, the sun's gravity is stronger than the centrifugal force and there is a bulge toward the sun that is just about equal to the first one. The Earth has bulges from both the sun and moon. The magnitude of the bulges changes with the distances from the earth to the tide producing body. The position of the bulges varies with the orientation of the earth's axis to the sun and the position of the moon relative to the Earth's equator. There is also the complicated interaction between the solar and lunar tides as the moon orbits the Earth. It is the tidal variation due to this interaction that is associated with the most difficult to explain earthquake signatures.

As the earth rotates, different parts of it pass through different parts of the bulges. A locality will pass through two tidal bulges per day (diurnal variation). The magnitude of the bulges will vary with a period half of the lunar cycle (fortnightly variation) and with the distance to the moon and sun. For a more rigorous treatment of tidal periods see Longman (1959) or Pollack (1973).

Tides, solar activity and Earth rotation. The Earth rotates about its axis approximately once every 23 hours and 56 min, but this rate is not constant. The length of a day varies on the order of a millisecond. This change is caused by the positions of the sun and moon. As the solar and lunar positions change, the locations of the tidal bulges are altered. The changing positions of the tidal bulges, in turn, affect the Earth's moment of inertia. The rate of rotation changes because angular momentum is conserved.

Table 1. Cycles in Earth rotation

Cycle Length	Change in Length of Day in Milliseconds	Description
13.63 days	0.34	The moon is in the plane of the ecliptic every 13.63 days where on the average it increases the moment of inertia.
13.66 days	0.82	The moon is above the equator every 13.66 days.
14.77 days	0.078	The time between full and new moon.
27.56 days	0.87	The time between perigees.
182.62 days	5.1	The sun is over the equator every half year.
1 year	1.6	Time between perihelia.
4.42 years		The 13.66 and 27.56 day periods are in phase.
9.3 years		The 13.63 and 13.66 day periods are in phase.
9.5 years		The half yearly and 13.66 day periods are in phase at the same lunar-solar angle.
11 years	0.16	Solar activity cycle.

Imagine a spinning figure skater. When her arms are outstretched, her moment of inertia is maximized and she turns slowly. As she brings her arms in toward her axis of spin, her moment of inertia decreases and she spins faster. It doesn't matter whether her arms are above her head, down at her sides, or folded against her chest; as long as the mass is brought close to the axis of spin, the effect is the same.

The Earth's tidal bulges have the same effect as the figure skater's arms. When the tidal bulges are brought near the Earth's axis, or are diminished in magnitude, the moment of inertia decreases and the Earth picks up speed. The tidal bulges are brought nearer to the axis by increasing their distance from the equator. This happens when the declination of the moon and/or sun increases. The tidal bulges are diminished when the sun and moon are at right angles to each other (first and last quarter) or when the moon or sun is further away.

Table 1 shows the principle periods in the Earth's rotation and their approximate change in the length of day. [See Munk and McDonald (1960), Yoder et al. (1981) and Kokus (1988c) for further discussion of changes in the length of day.] The peaks of these periods will occasionally add together, and the periods between the combined peaks are also listed in Table 1.

Solar activity also produces a measurable effect on the Earth's rotation. When there are solar flares, the atmosphere expands, its moment of inertia increases and this produces a drag on the earth, slowing it down. The earth reaches its maximum rotation rate about two or three years after a minimum of solar activity. During periods of high solar activity, the Earth rotates slower, but this is also when it experiences its greatest decelerations. These phenomena have been described by Sytinsky (1963-1982), Kalinin (1974), Kalinen and Kiselev (1976), Gribben (1971), and Currie (1980).

Ocean tides. Leypoldt (1941) and Berg (1966) have both shown evidence that ocean tides are correlated with nearby quakes.

Earth tides and seismic events. The solid Earth has tides, much the same as the ocean, except that the magnitudes are much smaller. According to the standard model, the earth tidal force is much smaller than the tectonic forces involved in earthquakes, but it may be “the straw that broke the camel’s back.” Davison (1896, 1934a, 1934b and 1938), Oldham (1903), Fuller (1912), Yamaguti (1931), Allen (1936), Stetson (1937), Mount Serat (1940), Hoffman (1961), Robson (1962), Ryall (1968 and 1981), Shlein (1972), Filson (1973), Kayano (1973), Bloxsom (1974), Sauck (1975), Tamrazyan (1974), Heaton (1975), Klein (1976), Dzurisin (1980), Mohler (1980), Souriau (1982) Palumbo (1986), Ulrich (1987), and Cochoran et al. (2004) found positive correlations between shallow focus earthquakes and Earth tides. Stetson (1935) found a positive correlation for deep focus earthquakes and tides. Mauk and Kienle (1973), Mauk and Johnston (1973), McNutt and Beavan (1981 and 1984) and Lowenstein (1987) detected tidal correlations with volcanic eruptions.

Tidal triggering in shallow focus quakes is contradicted by Knopoff (1964), Willis (1974), Shudde and Barr (1977), Shlein and Toksoz (1970) Simpson (1967a) and Heaton (1982). Spitaler (1937) and McMurray (1941) found no correlation between earth tides and deep focus quakes. Semmola (1898) did not find a lunar period in Mt. Vesuvius eruptions.

Why do different researchers get different results? The positive studies tend to look at very limited types of quakes and allow for a phase difference between the maximum tidal stress and the occurrence of the quake. Allen (1936) put it this way: “The second obstacle (to the acceptance of tidal triggering) has been the idea, now disappearing, that the lunar effect, if it exists, should appear in the same manner over the entire Earth, without regard to the strike or hade of the faults involved, or the nature of the earth stresses acting upon these faults. In consequence, statistics from the entire globe were assembled by men who doubted the possibility of a lunar effect, to prove their case. This procedure naturally would cancel the differing effects upon different fault structures, and result in the display of a negligibly small correlation.” Klein (1976) makes a similar point: “An approach that has failed to demonstrate significant tidal triggering is the use of large catalogues of earthquakes from a large geographic area. Any tidal correlation of earthquakes in a small region, in a certain magnitude range, or of a particular type such as aftershocks may be masked by averaging with a large sample of random earthquakes.”

The negative studies also make an error in logic. They assume that the only effect that the sun and moon can have on earthquakes is through the action of earth tides at the fault. The evidence strongly suggests another mechanism.

Most studies that look for a diurnal period usually find one. Studies that look for a correlation with the fortnightly tide often do not, while most of the studies that find a relationship with lunar phase often find at least one cluster that is inconsistent with a tidal effect. Studies that look at longer lunar periods (>4.4 years) do not find a correlation with periods associated with tidal maximums but do find correlations with periods associated with rotation rates. The rotation rate periods are half the periods associated with tidal maximums. (In other words, a 9.5 year period shows up very strongly, a 19 year period is weak at best.)

Diurnal periods in earthquakes. There are a number of periods in seismic activity that have been consistently identified by numerous researchers with various backgrounds in different geographic areas. One of the most perplexing is the diurnal period. Aristotle, Davison (1938), Shimshoni (1971), Kokus (1988b), Zhuravlev et al. (2006), Gravilov et al. (2010), and Sidorin (2010) have observed an increase in earthquake activity at night. While in some cases this may be explained by an increased observational sensitivity at night due to the absence of anthropogenic noise, in many cases it definitely is not.

There is absolutely no known mechanism within any of the standard theories of gravitation or geology that would explain this. What this means is that there is an increase in earthquakes on the side of the Earth opposite the sun. Tidal stresses can be ruled out because they are roughly symmetric both toward and away from the sun. Also there is no equivalent phenomenon for the moon which has a greater tidal force.

But there is even a more curious aspect of this phenomenon. Sidorin (2010a, b & c) in several comprehensive studies has shown that the diurnal period in earthquakes changes phase during the equinoxes and to a lesser extent during the solstices. The earthquake peak shifts abruptly from between a little before to a little after midnight (or the opposite) as the Earth passes thru seasons. This suggests that a non-Newtonian/non-Einsteinian force might be linked to a coupling of the earth's spin angular momentum and its orbital angular momentum. Imagine an electromagnetic analogy. Assume that the Earth has a net electric charge. It would create a magnetic field due to its rotation and another field due to its motion about its orbit. The two fields would add or subtract at different points in space at different times. They would produce four distinct patterns corresponding to the four seasons.

Seismic periods and lunar phase. There is much folklore concerning lunar phase and seismic activity. Much of it turns out to have some truth in it. If we look at volcanoes or earthquakes that tend to repeat themselves, we get three distinct patterns. Seismic events tend to cluster at either full and new moon, or first and last quarter, or when the angle between the sun and moon is near 135 or 315 degrees. The full and new moon signature is compatible with tidal stress which has been covered. Seismic signatures that contain the first and last quarters of the moon were found by Wood (1918), Jaggar (1920-1947), Hawaiian Volcanic Observatory (1927), Davidson (1938), Johnston and Mauk (1972), Mauk and Johnston (1973), Hamilton (1972), Sauers (1986a), Ritter (1987), Kokus and Ritter (1988) and Kokus (1988b). Clustering about 135 and/or 315 degrees has been reported by Henry (1917), Allen (1936), Bagby (1975b), Ritter (1987), and Kokus (1988a).

Earthquakes and eclipses. The folklore relating eclipses to seismic events ranges from Aristotle, to the Book of Matthew, to Disney's Fantasia, and anecdotal evidence abounds. But there are very few rigorous studies that have been published. In a sample of major quakes in the western United States, Kokus (1988b) found that their temporal correlation with eclipses had a 0.97 significance.

Seismic periods related to variations in earth rotation. Solar tides cause annual and semiannual periods in Earth rotation. Seismic variations with these periods have been observed by Spalding (1915), Conrad (1933 and 1934), Davison (1893, 1928 and 1938), Morgan et al. (1961), Eggars and Decker (1969), Shneiderov (1973), DeSabbatta and Rizzati (1977), McClellan (1984) and Stothers (1989a).

Every **4.42 years** the moon is simultaneously above the equator and at its point of orbit where it is closest to the Earth. Jaggars (1945), Bagby (1972 and 1975b), Winkless and Browning (1975), Rinehart (1973) and Roosen et al. (1976) all found 4.42 year seismic periods.

Every **9.3 years**, half-nodical and half-sidereal terms are in phase. Jaggar (1945), Ward (1961), Lamakin (1966), Hamilton (1973) and Shirokov (1973 and1983) found periods close to 9.3 years in volcanism and earthquakes.

Every **9.5 years** the half-yearly, and half sidereal terms are in phase at the same lunar-solar angle. This is perhaps the most curious of seismic periods, but it is the one with the strongest evidence. Hamilton (1973) detected a strong 9.5 year period in volcanic eruptions. Stothers (1989b) undertook the most detailed study of volcanic cycles to date. With a global sample of 380 events over a 400 year period he found a 9.5 year period at a very high confidence level (he could rule out a 9.3 year period). This is especially noteworthy because, as his study notes, he was looking for an 11 year period. Kokus (1988c), using the archives of the Foundation for the Study of Cycles, has traced the 9.5 year cycle from the volcanic dust veil index, to climate variation, to biological populations, to agricultural yields, and even to business cycles.

Not only does the earth's rotation vary with the approximate 11 year sunspot cycle, but quick decelerations due to solar flares are common during the active part of the cycle. It should be no wonder that researchers find seismic peaks at both sunspot minimums and maximums. Kluge (1863), Poey (1874), Swinton (1883), Koppen (1896 and 1914), Espin (1902), Jensen (1902 and 1904), O'Reilly (1899), Lyons (1899), Davison (1927 and 1938), Jaggar (1931 and 1945), Stearns and MacDonald (1946), Dewey (1958), MacDonald (1960), Machado (1960), De Mendoca Dias (1962), Sytinskiy (1966,1973a, 1973b and 1982), Simpson (1967b), Tamrazyan (1968a), Gribben (1971), Abdurakhomanov et al. (1974 and 1976), Kalinin (1974), Bagby (1975a), Kalinin and Kiselev (1976), Singh (1978), Jakubcova and Pick (1987), Barsukov (1988), Stothers (1989b), Kokus (1988a & b), Gousheva et al. (2003), Kolvankar (2008), Kolvankar et al. (2010), and Choi and Maslov (2010) found correlations between seismic activity in a variety of samples and the 11 year solar activity cycle. Feyman et al. (1984) found a correlation with the 88 year Gleissburg cycle of sunspots. (For a more thorough discussion of seismic periods see Kokus 1989.)

Earth-moon alignment in absolute space. Sadeh (1972 and 1978), Sadeh and Meidav (1973), and Shirley (1986b, 1986c and 1988) discovered a relationship between increased seismic activity and the position of the moon from the Earth as measured from the distant stars. This correlation was disputed by Mast (1972) and Hunter (1978). The lunar position associated with the increase in activity coincided with the vernal equinox. Therefore this particular alignment tended to put the tidal bulge due to the moon over the Earth's equator, maximizing the Earth's moment of inertia.

Typical seismic signatures. Seismic signatures can be grouped into three basic archetypes. 1). Events that cluster around full and new moon when other factors are combined to enhance the tidal bulges such as the moon being at perigee. These could very well be the result of tidal triggering. 2). Events that cluster around the first and last quarters of the moon with the other factors combining to minimize the Earth's moment of inertia and maximize its rotation rate. This also tends to exaggerate the difference in the moments of inertia of oceanic and continental plates. It also minimizes tidal magnitudes and the total surface area of the Earth. This signature is not compatible with the standard theory. 3). Events that cluster around lunar-solar angles of 135 and 315 degrees. This is the pattern of quakes that occur at the most studied fault site in the world—Parkfield on the San Andreas Fault. These quakes also tend to occur about 2 years after the sunspot minimum or when the earth's rotation rate reaches its maximum during the solar cycle. Kokus (2006) has suggested that this is when the tidal bulges are furthest away from a line connecting the Earth's center and the moon's center. This would maximize the torsion that the moon exerts on the tidal bulges that is perpendicular to the Earth's rotation axis.

My proposal. I hope that the readers of NCGT help me in updating this bibliography and bringing to my attention any omissions. I also believe that it would be a great help to researchers in this field if the older documents were scanned and put online. I would appreciate any and all help in doing this. My greatest wish is that a younger man would take over this project.

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SUN, MOON AND EARTHQUAKES

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Abstract: During a study conducted to find the effect of Earth tides on the occurrence of earthquakes, for small areas of high-seismicity regions, it was noticed that the Sun's position in terms of universal time (GMT) shows links to the earthquake-lunar distance together with Sun-Earth-Moon angle. This paper provides the details of this relationship after studying earthquake data for over forty high-seismicity regions of the world. It was found that nearly 98% of the earthquakes for these different regions, examined for the period 1973-2008, show a direct relationship between the Sun's position and the earthquake-moon distance together with the Sun-Earth-Moon angle. As the time changes from 00-24 hours, the sum of the earthquake-moon distance and the Sun-Earth-Moon angle changes through 360^0, and plotting these two variables for different earthquakes reveals a simple 45^0 straight-line relationship between them.

Keywords: *Earth-Moon distance (EMD), Sun-Earth-Moon angle (SEM), solid Earth tides, earthquakes, earthquake triggering.*

Introduction

Many workers have studied the effect of the Sun and Moon on the occurrence of earthquakes. Many of them have identified individual effects of the Sun and Moon. Some research workers reported EM emissions prior to earthquakes and volcanic eruptions which were of a semidiurnal or diurnal type (Kolvankar et al., 1992). The semidiurnal type was commonly observed. However, the diurnal type of EM emission was also noticed in few cases. Both these types of EM emission were observed in a very broad frequency band from VLF to microwaves. Low-frequency electromagnetic emissions were reported as precursors to the volcanic eruptions at Mt. Mihara during November 1986 (Yoshino and Tomizawa, 1989). Radio emissions in the HF band were observed prior to the Great Chilean earthquake of 22 May 1960 (Warwick et al., 1982). Similar interferences were also reported during the Apollo Lunar Seismic Experiment in the microwave band (Bulow et al., 2005). The precursory signature effect of the Kobe earthquake was reported to be VLF sub-ionospheric signals (Hayakawa et al., 1996.). Interference in the UHF band was reported prior to and during the 1991 earthquake sequence from the Valsad Region, Gujarat, India (Kolvankar, 2001). Most of these types of interference were observed during the day and were equally spaced from local noontime, and it was concluded that they were induced by the Sun's position (Kolvankar, 2008).

Based on the diurnal type of EM emission observed at sunrise and sunset by many workers, efforts were made to align the earthquake data over 24 hours utilizing local time. This data showed higher earthquake counts from 00 hours (midnight) to 06 hours and indicated a pattern, inversely proportional to the daily atmospheric temperature variation. It showed the influence of the horizontal component of Earth's magnetic field, which is susceptible to atmospheric temperature. This phenomenon again depends on the Sun's local position (Kolvankar et al., 2010).

The Moon has a larger gravitational pull on the Earth than the Sun and many workers have shown the effects of the Moon on the occurrence of earthquakes. It is observed that moonquakes occurred in large numbers when the Moon is at apogee and perigee (Lammelein et al., 1977; Runcorn, 1977; Bullow et al., 2005; Latham et al., 1971). It has been shown that earthquakes at a few places in China occurred at times of a certain combination of planetary positions (Li, 2006). The lunar periodicities and their effects on earthquakes were studied in detail. It was found that the earthquake counts go up steadily from apogee to perigee and also towards full Moon. Lunar movement from ascending node to the next ascending node also provides a certain earthquake pattern. Major earthquakes are more numerous when perigee coincides with full Moon and new Moon than at apogee with a similar combination (Kolvankar et al., 2010).

The tidal effect on the Earth body due to both the Sun and Moon has been extensively studied in recent years. However, using very old data (1900-1950), Tamarazyan showed the distribution of major earthquakes relative to solar and lunar tides (Tamarazyan, 1968). The correlations of the occurrence time of the foreshocks and the lunar and solar local hour angles over a period of time prior to a mainshock were noticed (Gao, 1996). A study of the San Andreas Fault found a link between the gravitational tug that creates the tides and small tremors beneath the ground. Micro-earthquake activities in the Tamba Plateau increased after a new Moon and a full Moon during 1995 and 1996 (Iwata et al., 2002). A large number of publications established a clear correlation of shallow-focus and smaller magnitude earthquakes with the Earth tide (Metivier et al., 2008; Cochran et al., 2004). Tanaka observed tidal triggering of earthquakes prior to the three giant earthquakes occurring off Sumatra on 26 December 2004 (Mw 9.0), 28 March 2005 (Mw 8.6), and 12 September 2007 (Mw 8.5). Statistical analysis indicates a high correlation for several to ten years preceding the occurrence of the large earthquakes. The correlation vanished after the main events (Tanaka, 2010). Hayakawa et al. studied the tidal effect on different seismogenic phenomena, and found that lithospheric ULF emissions exhibit a clear maximum-minimum-maximum pattern synchronized with the lunar phase during several months before the EQ (Hayakawa et al., 2009).

Characteristics of the earthquake-triggering pattern by Earth tides were studied utilizing over five hundred thousand events from an earthquake catalogue (NEIC-USGS) for global earthquakes with a magnitude range of 2 to 10. The study was conducted for different patterns of the triggered earthquakes for different ranges of periods, magnitudes, depths, latitudes and longitudes. This study indicated that Earth tides trigger earthquakes at all depths and up to magnitude 5.0. The lateral stresses applied during Earth tides close to the full Moon phase are found to be more effective than the stresses of Earth tides during the new Moon phase. However, close to the new Moon phase, earthquakes of magnitude up to 3.0 and of shallow focus range up to 10 km are triggered directly by the combined pull of the Moon and Sun (Kolvankar et al., 2010)

Methodology used for the Earth tide study

To study the effects of Earth tides on the occurrence of earthquakes, the earthquakes were plotted on the vertical axis against the new Moon - full Moon - new Moon (NM-FM-NM) which represents the horizontal axis. For each event from the earthquake catalog, the moon position (longitude) was obtained and the value of the SEM [Sun-Earth-Moon] angle was added before the earthquake was plotted with respect to the lunar position. For studying the effect of Earth tides on the occurrences of earthquakes, a total of 96 columns were used representing 360^0 of Earth rotation as well as for the lunar rotation around the Earth. Considering the Earth's self-rotation and lunar rotation around the Earth, the SEM angle at new Moon and full Moon are considered as 0^0 and 180^0 respectively. The earthquake count, which represents the Y-axis, is incremented for each earthquake coinciding with one of the 96 columns. This study of the effect of Earth tides was carried out for different set of periods, latitudes, longitudes, magnitudes, depths etc. (Kolvankar et al., 2010).

During this study it was noticed that the variation of the horizontal component of the earthquake plot (NM-FM-NM (which is also represented as -180^0 00^0 $+180^0$), has some bearing on the timing of earthquakes picked from a small area of a high-seismicity region. This paper studies and explores this phenomenon in detail.

Study of data related to different high-seismicity regions of the world

Fig. 1 provides a seismicity map of the world. Here we carried out an exercise of plotting earthquakes for different small high-seismicity regions (the greenish area in the map) of the world in XY plots with the X axis representing the sum of [Distance between earthquake location and Moon (A)] and [Moon travel (towards east @ around 12.12^o/day) (B)] and the Y axis representing the Sun position/GMT timings. For convenience, hereafter, the quantity (A) is called EMD, earthquake-Moon distance (earthquake longitude – moon longitude) and quantity (B) Moon travel (illustrated in **Fig. 1**), which also represents Sun- Earth-Moon angle, is called the SEM angle. Both these quantities are measured in degrees. **Fig. 2** shows the SEM angle for different moon positions when it moves from new Moon (NM) to the next new Moon (NM) through Full Moon (FM).

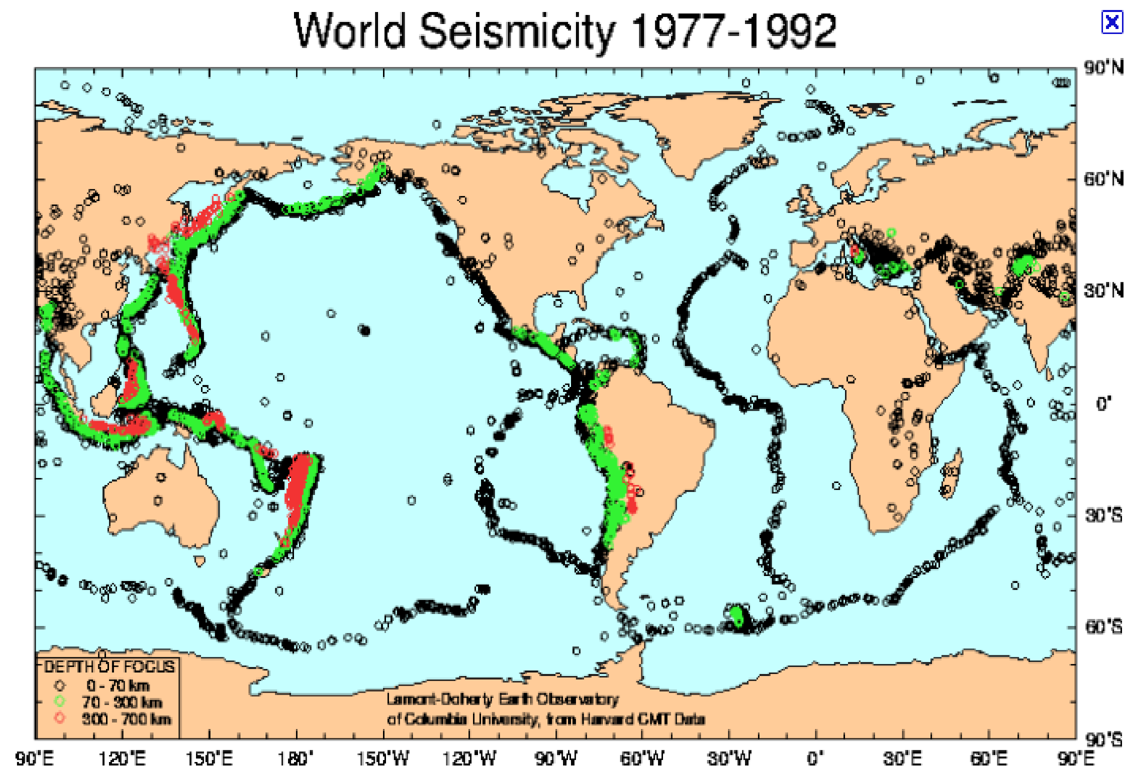

Fig. 1. World seismicity map (Courtesy of NEIC-USGS)

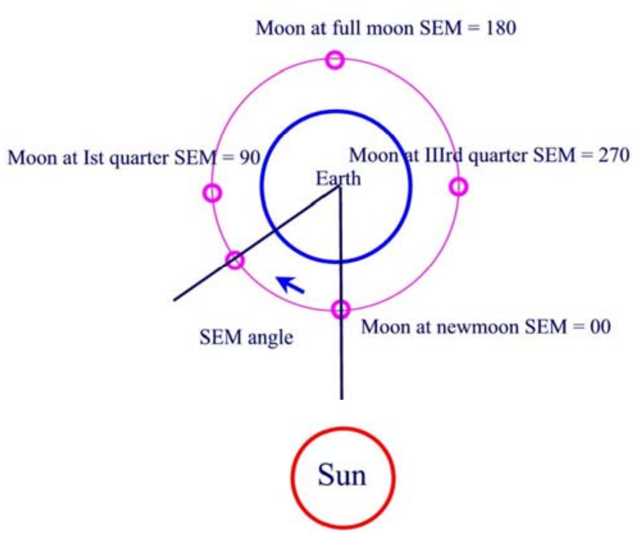

Fig. 2. SEM angle for different moon positions when it moves from new Moon (NM) to the next new Moon (NM) through full Moon (FM).

It should also be noted here that the individual quantities EMD & SEM vary with time. Due to the Earth's self-rotation, the EMD for a specific earthquake location varies almost by 360^0 in 24 hours, whereas the Moon travels eastward (SEM) at the rate of about 12^0 in 24 hours. So, for any specific earthquake location there are numerous possibilities for earthquake occurrences within Earth's self-rotation of 24 hours.

To illustrate the plotting of earthquakes in this graph for (EMD+SEM) vs GMT timings (solar position), we selected a few high-seismicity regions of the world with different sets of longitude ranges. Though there are many high-seismicity regions on the Earth, they do not cover the entire longitude range from -180^0 to $+180^0$. A set of 24 XY earthquake plots for (EMD+SEM) vs GMT timings for different earthquake regions of the globe are shown in **Figs. 3 to 6**. The plots are drawn for different combinations of latitude and longitude ranges. For convenience, the plots are drawn for different periods, depending on the seismicity of the regions. Information about latitude and longitude ranges, together with the period (provided for the year 2000 in most cases) and total earthquake count, is provided at the top of each plot.

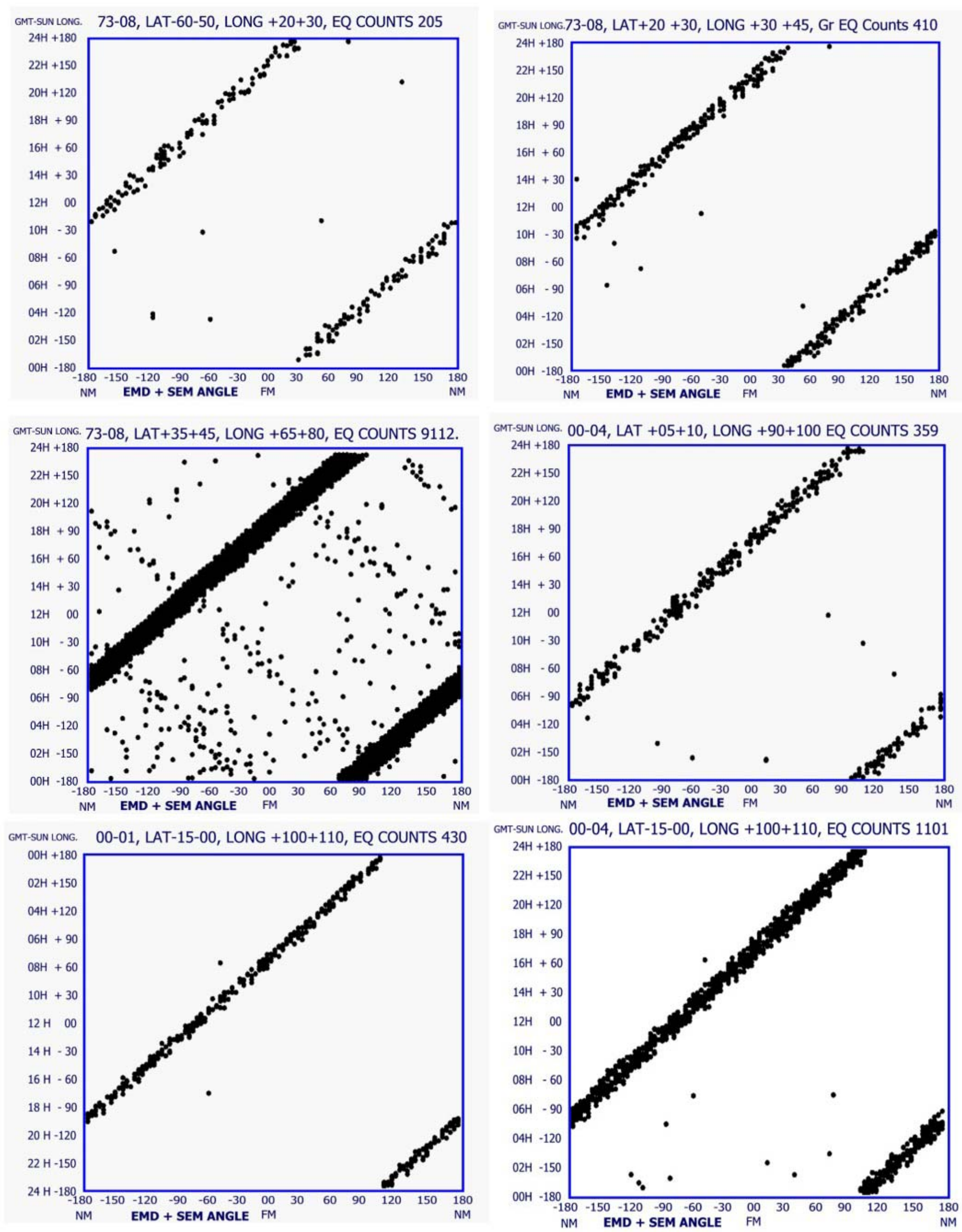

Fig. 3. First set of six XY plots for earthquakes, (EMD+SEM) vs GMT timings (Sun position) are shown for different latitude-longitude ranges and periods. This information along with the earthquake count is provided at the top of each plot. In all these plots, for 00 hours GMT, earthquakes commence on the X axis (EMD+SEM) at the mean longitude range of the area under study.

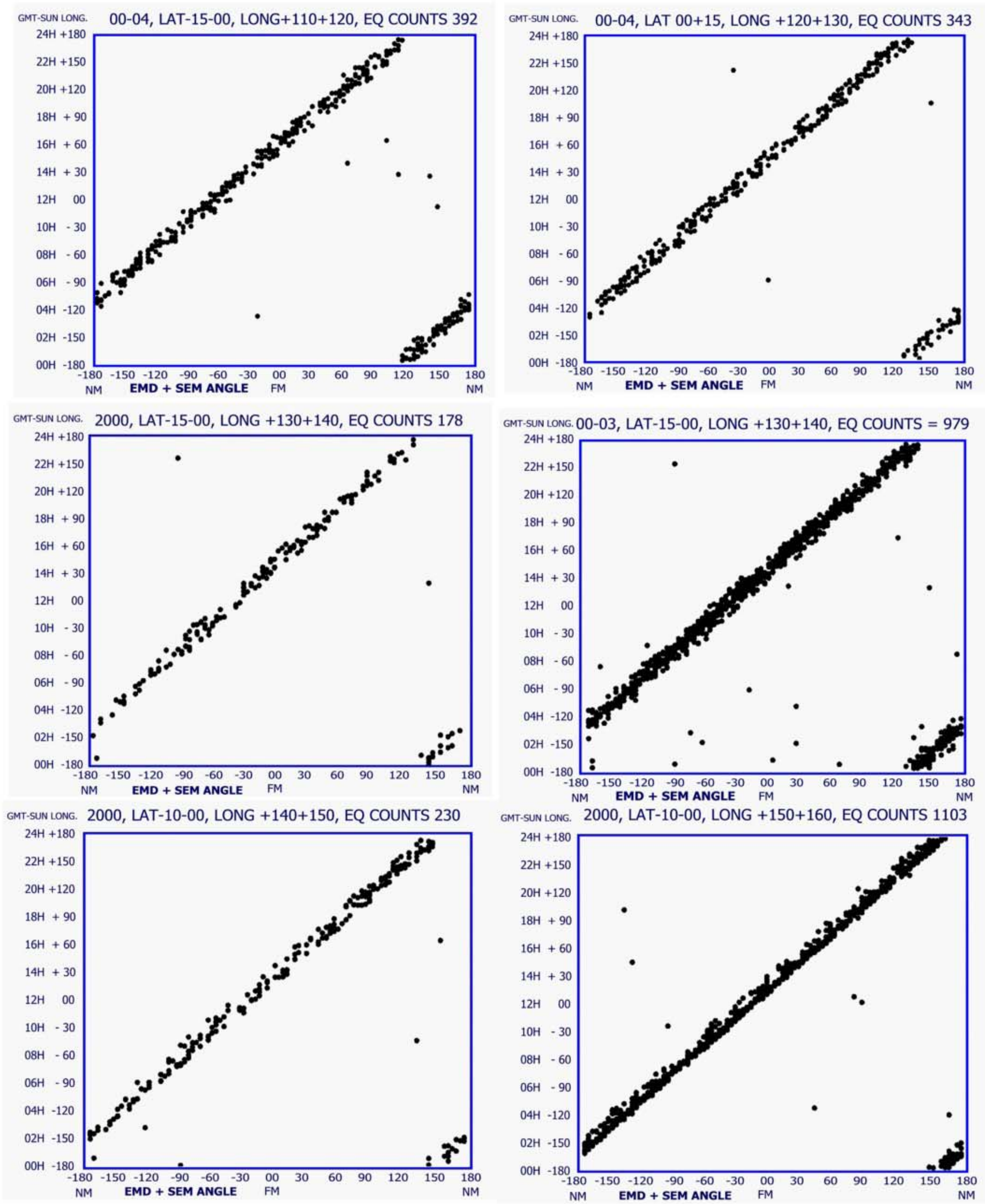

Fig. 4. Second set of six XY plots for earthquakes, (EMD+SEM) vs GMT timings (Sun position), are shown for different latitude-longitude ranges and periods. This information along with the earthquake count is provided at the top of each plot. In all these plots, for 00 hours GMT, earthquakes commence on the X axis (EMD+SEM) at the mean longitude range of the area under study.

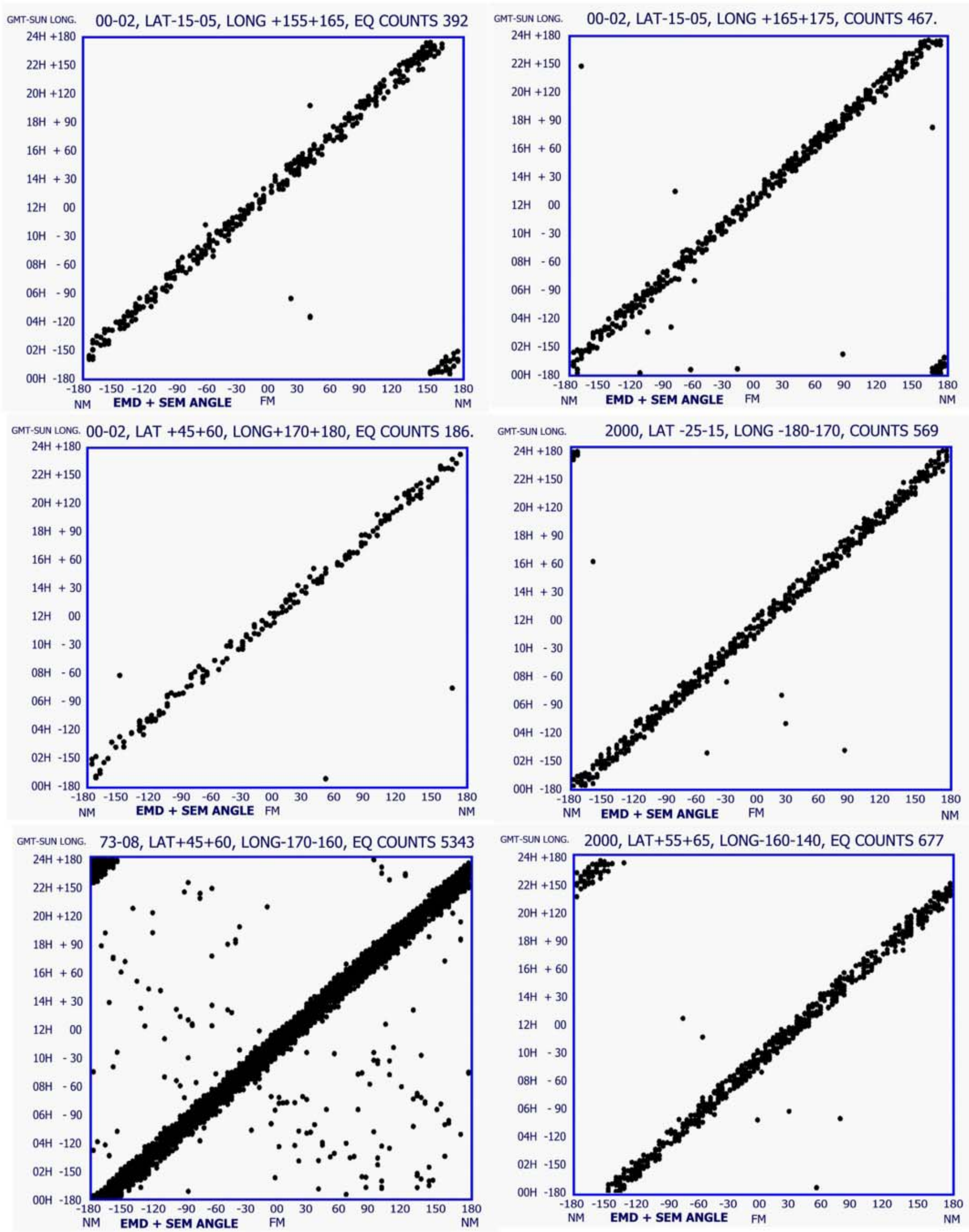

Fig. 5. Third set of six XY plots for earthquakes, (EMD+SEM) angle vs GMT timings (Sun position), are shown for different latitude-longitude ranges and periods. This information along with the earthquake count is provided at the top of each plot. In all these plots, for 00 hours GMT, earthquakes commence on the X axis (EMD+SEM) at the mean longitude range of the area under study.

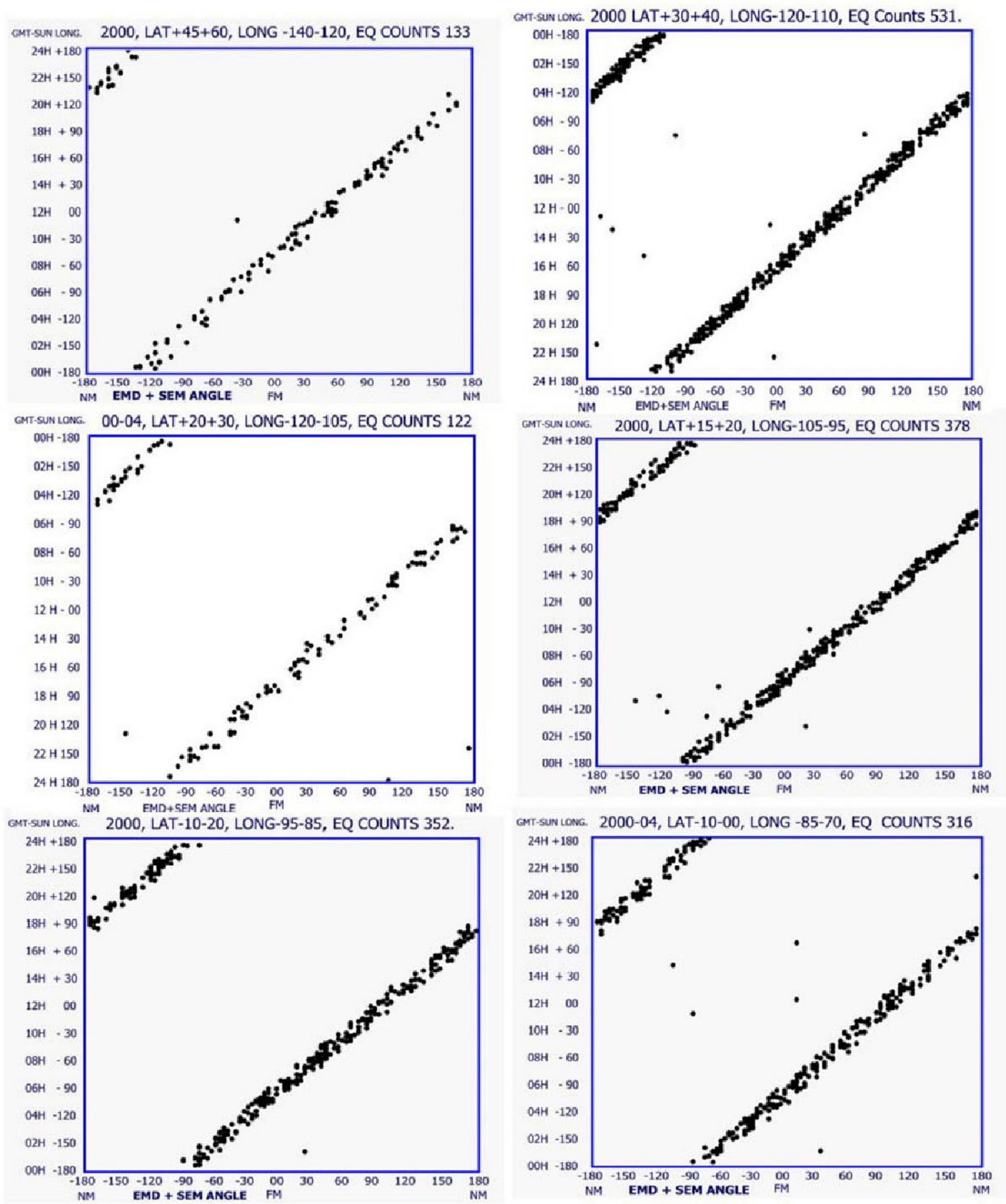

Fig. 6. Forth set of six XY plots for earthquakes, (EMD+SEM) vs GMT timings (Sun position) , are shown for different latitude-longitude ranges and periods. This information along with the earthquake count is provided at the top of each plot. In all these plots, for 00 hours GMT, earthquakes commence on the X axis (EMD+SEM) at the mean longitude range of the area under study.

Table 1 provides locations (latitude, longitude range [Lat-Long]) for different high-seismicity regions of the world along with earthquake counts (EQ COUNTS) for the period 1973-2008. For all plots drawn in **Figs. 3 to 6**, this table also provides the average earthquake count starting from 00 hours GMT for the location on the horizontal axis (in DEGREES) representing the EMD + SEM angle. For all these plots, when GMT time varies from 00-24 hours, the quantity for (EMD+SEM), varies through the entire range of -180^0 to $+180^0$. However the start count for 00 GMT varies for different longitude range. This is due to the position of the Sun, which is seen at a different angle for different longitudes.

Table 1. Table for earthquake counts for different high-seismicity regions of the world for the period 1973-2008, showing the relation between the Sun's position (GMT time) and the average count start on the X axis (of plots in Figures 3-6) representing the EMD + SEM angle.

REGION	LAT RANGE (IN DEGEES)	LONG RANGE (IN DEGEES)	GMT TIMING RANGE	EQ COUNTS	AVERAGE EQ COUNT START AT 00 GMT IN HORIZONTAL AXIS (IN DEGREES)
01	-25 \ -15	-180\-170	00-24 H	17670	-175
02	-35 \ -25	-180\-170	00-24 H	06365	-175
03	+45 \ +60	-180\-170	00-24 H	05223	-175
04	+45 \ +60	-170 \-160	00-24 H	05343	-165
05	+55 \ +65	-160\-140	00-24 H	18323	-150
06	+45 \ +60	-140\-120	00-24 H	03794	-130
07	+40 \ +50	-130\-120	00-24 H	07026	-125
08	+30 \ +40	-120\-110	00-24 H	17772	-115
09	+20 \ +30	-120\-105	00-24 H	00933	-110
10	+15 \ +20	-105\-95	00-24 H	10031	-100
11	+10 \ +20	-95 \ -85	00-24 H	08766	- 090
12	00 \ +10	-85 \ -75	00-24 H	03801	- 080
13	-10 \ +00	-85 \ -70	00-24 H	02326	- 080
14	-20 \ -10	-80 \ -60	00-24 H	04321	- 075
15	-30 \ -20	-85 \ -60	00-24 H	08263	- 075
16	-40 \ -30	-85 \ -60	00-24 H	08263	- 075
17	+10\ -40	-85 \ -60	00-24 H	27047	- 075
18	-60 \ -40	-85 \ -60	00-24 H	00541	- 075
19	-25 \ -18	-70 \ -60	00-24 H	05527	- 075
20	-60 \ -50	+30 \ +40	00-24 H	02460	+ 035
21	+35 \ +45	+65 \ +80	00-24 H	09112	+ 070
22	-05 \ +10	+90 \+100	00-24 H	08425	+ 095
23	+10 \ +30	+90 \+100	00-24 H	04219	+ 095
24	-15 \ +00	+100\+110	00-24 H	04466	+105
25	-15 \ +00	+110\+120	00-24 H	03885	+115
26	-02 \ +07	+120\+130	00-24 H	12710	+125
27	+07 \ +15	+120\+130	00-24 H	06308	+125
28	+15 \ +25	+120\+130	00-24 H	06697	+125
29	-15 \ +00	+120\+130	00-24 H	10420	+125
30	+25 \ +35	+125\+135	00-24 H	03353	+130
31	-15 \ +00	+130\+140	00-24 H	07001	+135
32	+20 \ +30	+135\+150	00-24 H	04758	+140
33	+10 \ +20	+135\+150	00-24 H	05703	+145
34	+30 \ +38	+135\+145	00-24 H	09464	+140
35	+38 \ +45	+135\+145	00-24 H	05272	+140
36	+40 \ +50	+145\+155	00-24 H	09555	+150
37	+45 \ +60	+155\+165	00-24 H	05799	+160
38	-10 \ +00	+150\+160	00-24 H	11218	+155
39	-15 \ -05	+155\+165	00-24 H	04203	+160

40	-15 \ -05	+165\+175	00-24 H	04311	+170
41	-25 \ -15	+165\+175	00-24 H	06732	+170
42	+45 \ +60	+170\+180	00-24 H	02463	+175

As illustrated, the earthquake plots drawn for different longitude ranges (with about 10^0 width) occupy a certain slot space in the XY plots. In most of these plots, not more than 2% of the earthquakes are seen in scattered form. However two of these plots, namely for Lat (45^0-60^0), Long (-170^0-160^0) and for Lat ($+35^0+45^0$) and Long ($+65^0+80^0$), provide more scattered earthquakes points. In all other cases, 98% of earthquakes align the 45^0-inclined broad lines. As stated earlier, earthquakes for different longitude ranges occupy different slots in this square plot. Plots drawn for a longitude range centered around 180^0 with about 10^0 widths on either side ($+170^0$ to $+180^0$ and -180^0 to -170^0) occupy the central strip running from the origin of the plot to the extreme corner at 45^0. All other earthquake plots are provided in two segments due to continuation of Earth longitudes at +/- 180^0. As stated earlier the earthquake plot commences (for 00 hours GMT) on the (EMD+SEM) axis at certain angle readings equal to the mean value of the longitudes of the area under study.

Fig. 7 shows multiple earthquake plots for (EMD+SEM) vs GMT timings, in combined form utilizing a color code for different set of plots. Most of these plots are illustrated individually in figures 2-5. The details of color plots used in this figure are provided on the right-hand side of this figure in terms of period/year, latitude range, longitude range and color code used. This figure provides plots of earthquakes, inclined at 45^0 and occupying independent areas, for different sets of longitude ranges and drawn for different periods between 1973 and 2008.

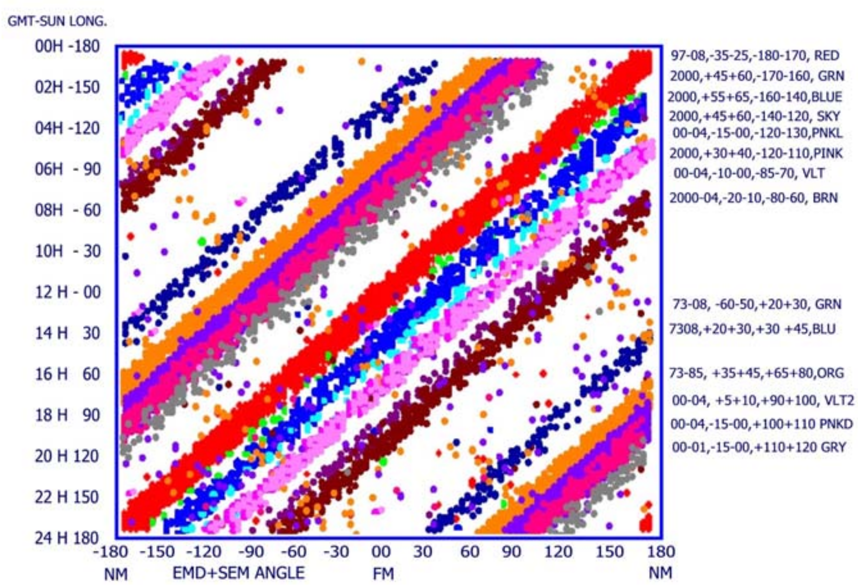

Fig. 7. Multiple earthquake plots for (SMD+SEM) vs GMT timings (separately illustrated in earlier figures), are illustrated in combined form in this figure utilizing a color code for different set of plots. The details of multiple parameters of each plot used in this figure are provided on the right-hand side of this figure: period/year, latitude range, longitude range, color code used.

Fig. 8 provides a simplified version of the above figure with the color code used for different earthquake plot segments, drawn for different longitude ranges.

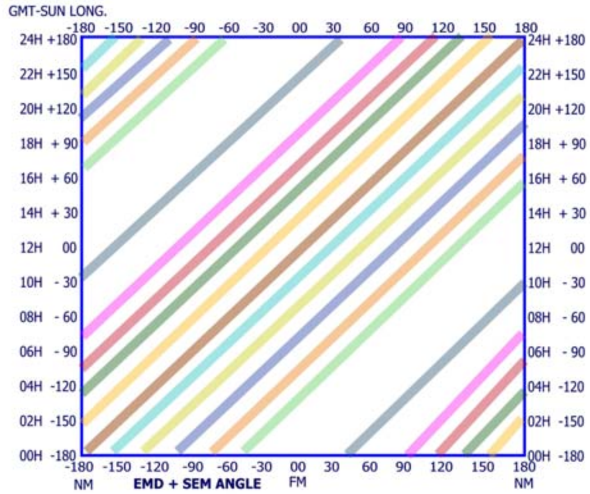

Fig. 8. A simplified version of Fig. 7 above, with the color code used for different earthquake plot segments for different longitude ranges.

Fig. 9 illustrates three earthquake plots for (EMD+SEM) vs GMT timings for latitude range -35^0 to -25^0 and longitude range -180^0 to -170^0 for three different twelve-year periods: 1973-1984, 1985-1996, and 1997-2008. The earthquakes occupy the same strip in these plots and there are no time-dependent variations.

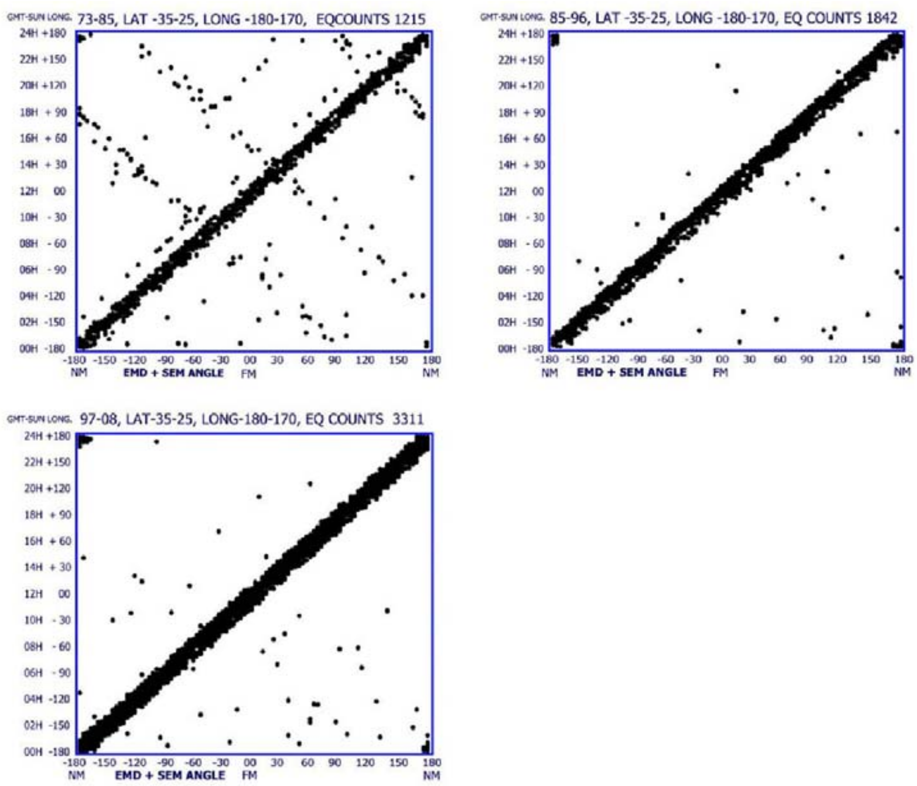

Fig. 9. Three earthquake plots for (EMD+SEM) vs GMT timings for latitude range -35^0 to -25^0 and longitude range -180^0 to -170^0 for three different twelve-years period: 1973-1984, 1985-1996, and 1997-2008. The earthquakes occupy the same strip in these plots and there are no time-dependent variations.

Fig. 10 shows earthquake plots for (EMD+SEM) vs GMT timings for almost the identical longitude range: -85^0 to -65^0. The first five plots provide for different latitude ranges displayed with different colors and the last one provides the combined plot for the entire region. The seismicity region is the west coast of South

America which runs from north to south as illustrated in a small figure at the bottom left of this diagram. This plot demonstrates that the different regions with an identical longitude range occupy a common area in these XY plots. This is due to the position of the Sun, which has an almost identical angle with respect to different regions along the South American coastline.

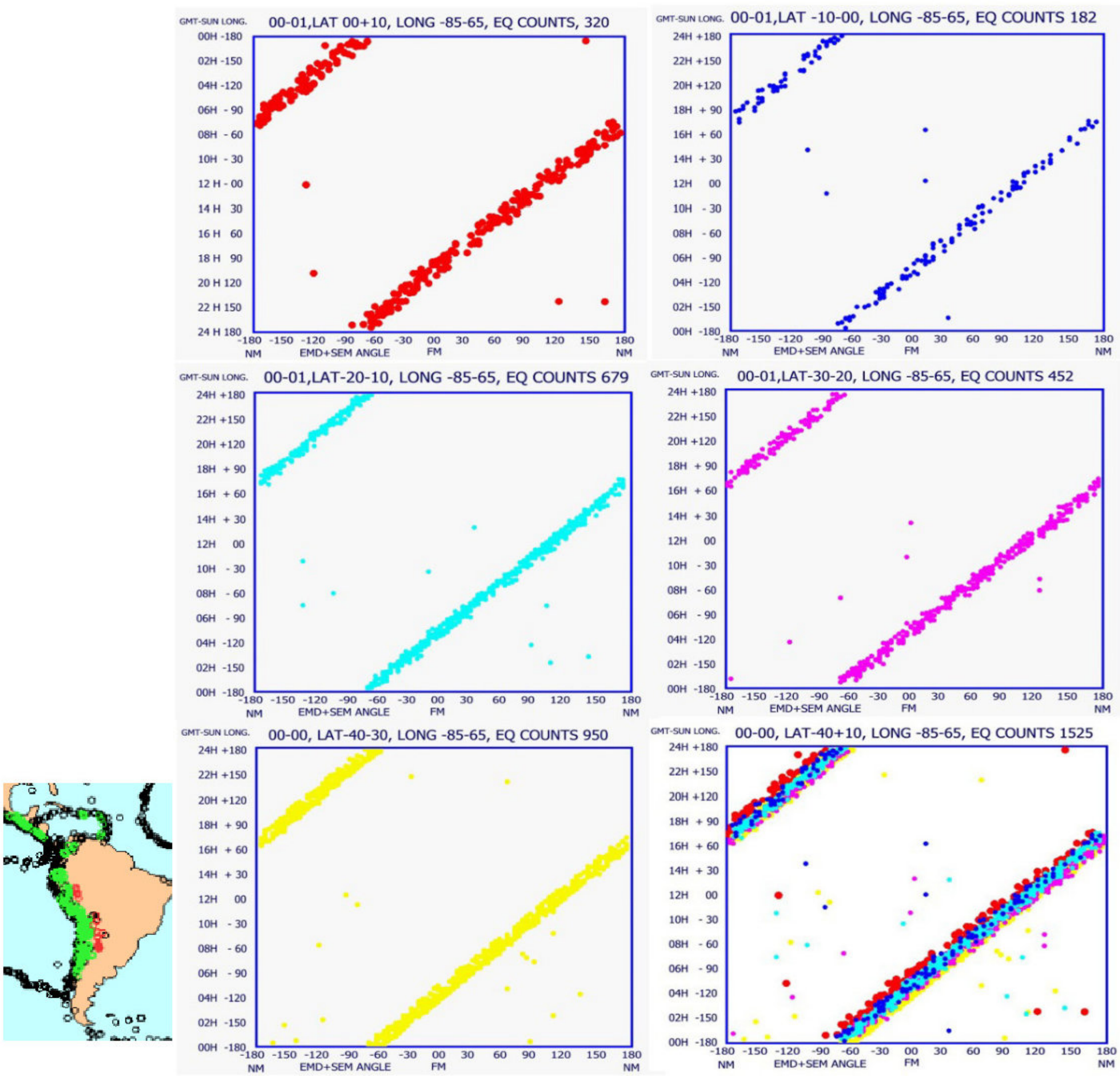

Fig. 10. Earthquake plots for (EMD+SEM) vs GMT timings for an almost identical longitude range of -85^0 to -65^0. The first five plots provide for different latitude ranges displayed with different colors and the last one provides the combined plot for the entire region. The seismicity region is the west coast of South America, which runs from north to south as illustrated in a small figure on the left.

Fig. 11 shows an earthquake plot for (EMD+SEM) vs GMT timings for latitude range 30^0 to 50^0, longitude range 20^0 to 40^0, for a lower magnitude range of 2-3 and for the year 1993. Hollow triangles are used here to indicate high densities of earthquakes on the edges (of the plot indicated by two arrows) caused by direct triggering close to the new Moon phase. The Earth tide plot for the same parameters is also provided, which illustrates high earthquake counts in the new Moon phase. This also indicates that even small earthquakes in the magnitude range 2-3 faithfully follow the basic pattern.

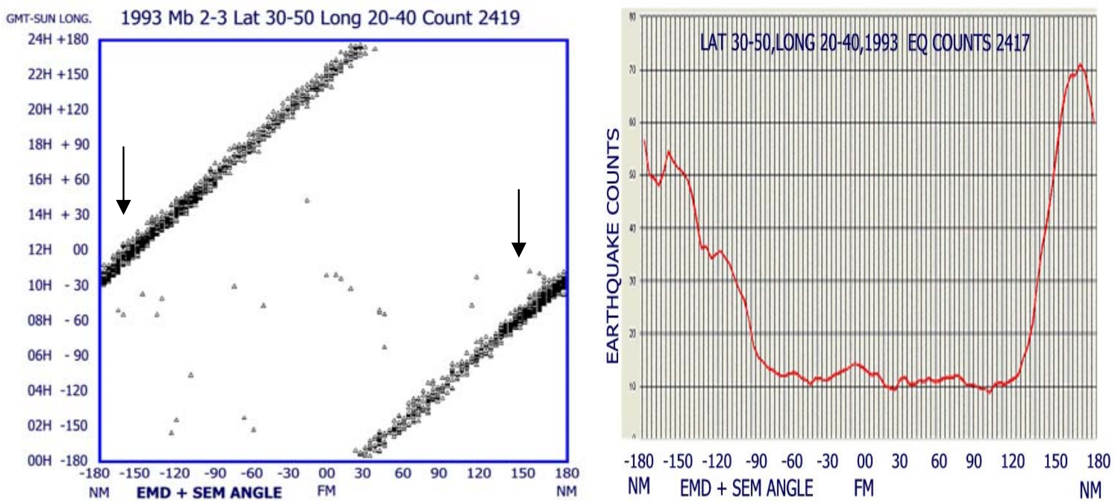

Fig. 11. This is a typical earthquake plot for (EMD+SEM) vs GMT timings, for latitude range 30^0 to 50^0, longitude range 20^0 - 40^0, for a lower magnitude range of 2-3 and for the year 1993. Hollow triangles are used here to indicate high densities of earthquake on the edges (indicated by arrows) caused by direct triggering close to the new Moon phase. The Earth tide plot for the same parameters is also provided, which illustrates high earthquake counts in the new Moon phase.

Study of aftershocks

When a major earthquake occurs at any particular place, it causes damage to the local structure and thus the region becomes very unstable. It is invariably observed that this type of situation leads to the occurrence of very large numbers of aftershocks within a couple of days. Hence it is interesting to see how this aftershock pattern appears in the plot of (EMD+SEM) vs GMT timings.

Figs. 12 and 13 show earthquake plots for (EMD+SEM) vs GMT timings for aftershock data (1 month period) for two massive earthquakes of magnitude 9.2 and 8.6 in the Sumatra region in 2004-05. The left-hand side of **Fig. 12** provides a 24-hour plot for forty consecutive days including the main event (00:58:23 on 26.12.2004, Lat. +3.3^0, Long. +95.98^0, Mb 9.0, EQ count 376). The right-hand side of this figure provides the earthquake plot for (EMD+SEM) vs GMT timings for the same data. All the 376 events including the main event faithfully follow the straight-line curve. **Fig. 13** similarly shows two plots for event 2 (28.03.2005, 16:09:06, Mb 8.6, EQ count 998). The left-hand plot provides a 24-hour plot for a period of over 40 days (including pre-earthquake period). The right-hand figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. This figure shows a few earthquakes at right angle to the plot line, which are probably caused by the vulnerable structure resulting from the main event. Such types of discrete events seen in other plots [plots drawn for Lat (45^0-60^0), Long (-170^0-160^0) and for Lat (+35^0+45^0) and Long (+68^0+80^0)] are probably caused by this factor.

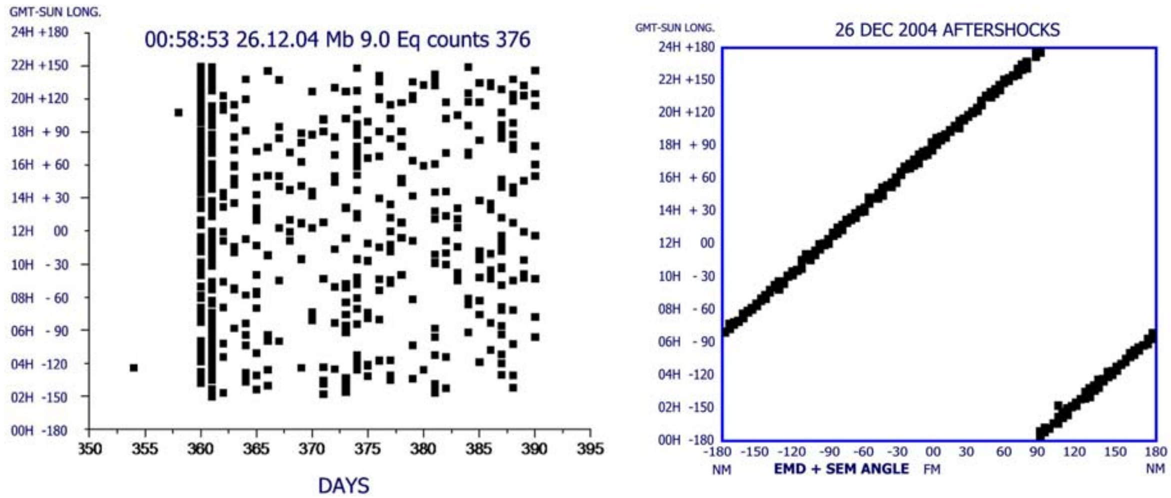

Fig. 12. The left-hand figure provides a 24-hour plot for forty consecutive days including the main event (00:58:23 on 26.12.2004, Lat.+3.3^0, Long+95.98^0, Mb 9.0, EQ count 376). The right-hand figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. All the 376 events including the main event faithfully follow the straight-line curve.

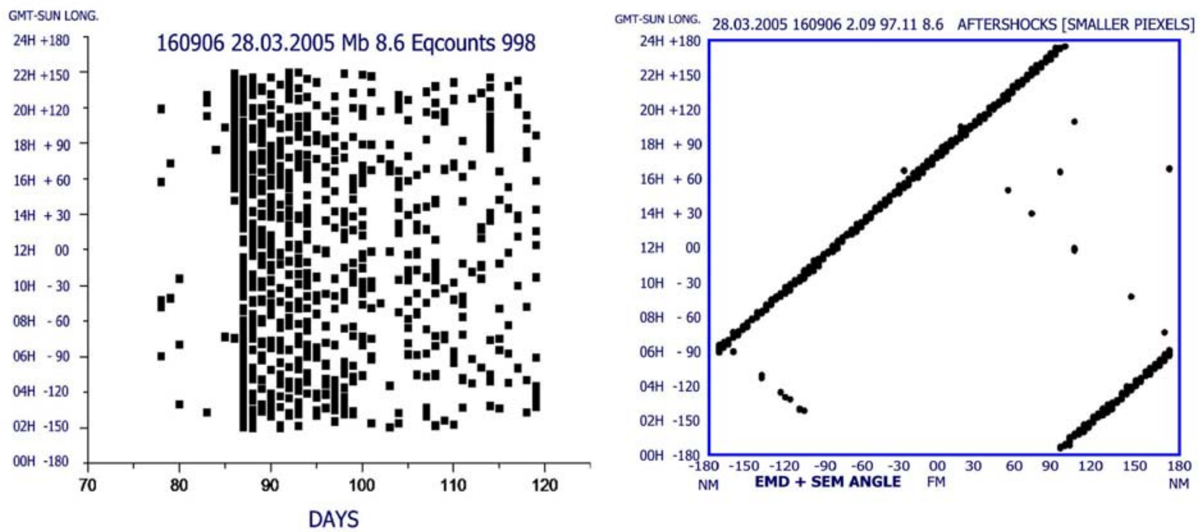

Fig. 13. The left figure provides a 24-hour plot for forty consecutive days including the main event (16:09:06 on 28.03.2005, Lat.+2.09^0, Long. +97.11^0, Mb 9.0, EQ count 998). The right figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. While most of the 998 events faithfully follow the straight-line curve, few earthquakes are seen at right angle to the plot line, which are probably caused by the vulnerable structure resulting from the main event. Such types of discrete events seen in other plots are mainly caused by this factor.

Fig. 14 provides a 24-hour plot for forty consecutive days including the main event (21:35:12 on 09.02.1978, Mb 7.7). The right-hand figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. Three earthquakes, which do not follow the straight line, might be caused by the vulnerable structure resulting from the main event.

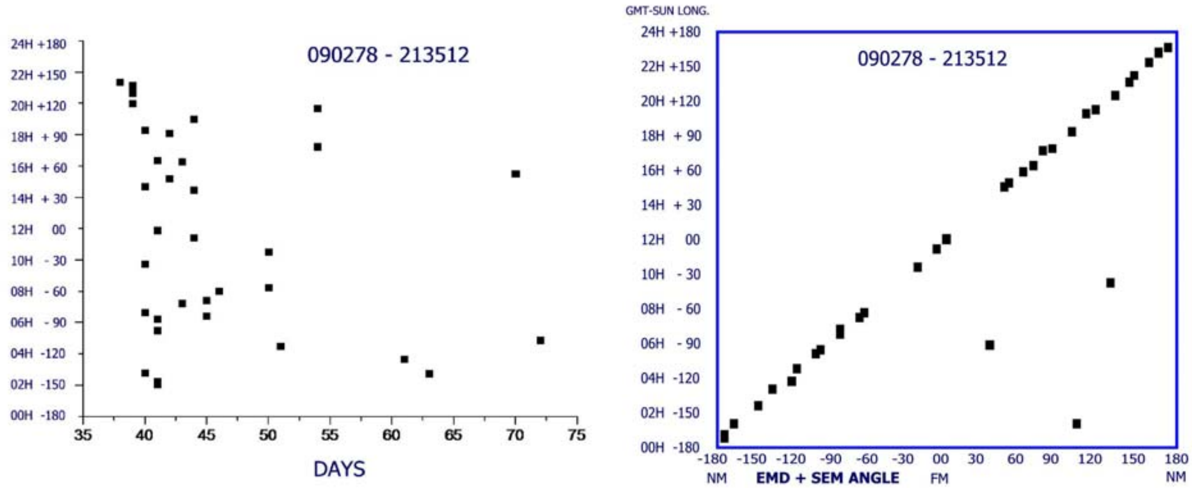

Fig. 14. The left-hand figure provides a 24-hour plot for forty consecutive days including the main event (21:35:12 on 09.02.1978, Lat.-30.68^0, Long.-177.36^0, Mb 7.7). The right-hand figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. Three earthquakes, which do not follow the straight line, might be caused by the vulnerable structure resulting from the main event.

Fig. 15 provides a 24-hour plot for thirty consecutive days including the main event (20:33:14, 23.06.2001, Mb 8.4). The right-hand figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. All the 131 events including the main event faithfully follow the straight-line curve.

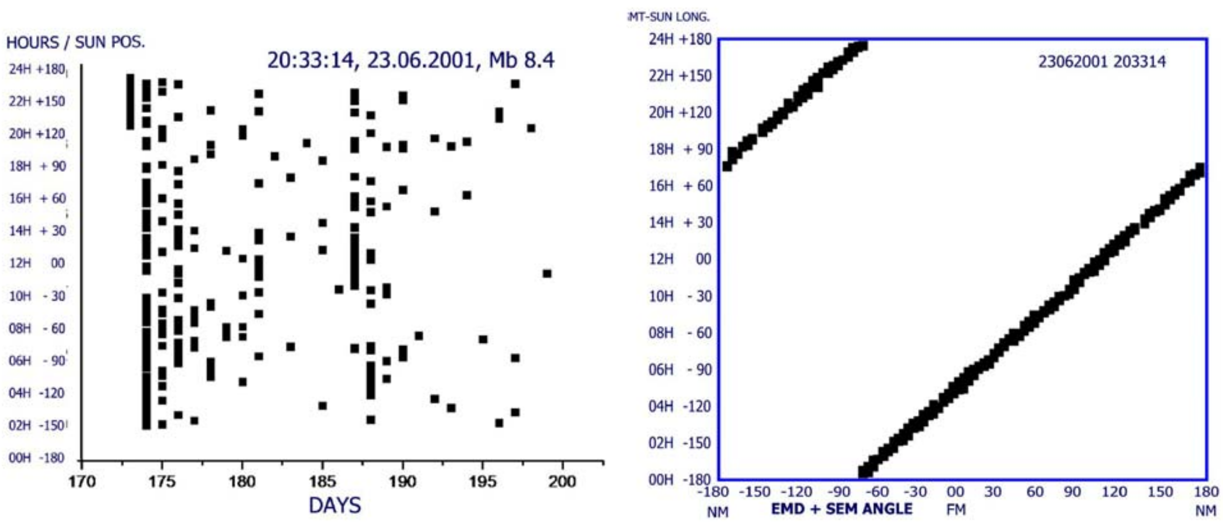

Fig. 15. The left-hand figure provides a 24-hour plot for thirty consecutive days including the main event (23.06.2001, 20:33:14, Lat.16.26^0, Long.-73.64^0, Mb 8.4). The right-hand figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. All the 131 events including the main event faithfully follow the straight-line curve.

Fig. 16 provides a 24-hour plot for thirty consecutive days including the main event (05:12:40, 30.07.1974, Mb 7.4). The right-hand figure provides an earthquake plot for GMT timings vs (EMD+SEM) for the same data. All the 11 events including the main event faithfully follow the straight-line curve.

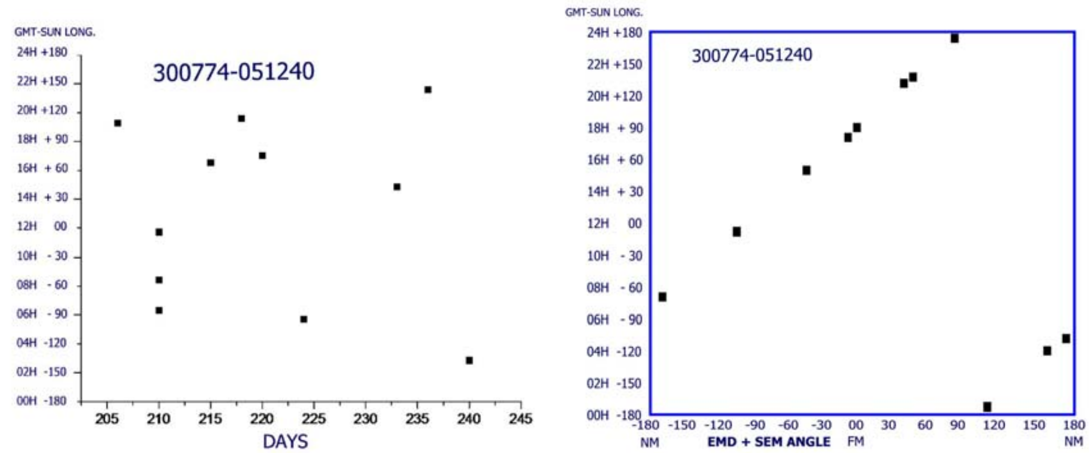

Fig. 16. The left-hand figure provides a 24-hour plot for thirty consecutive days including the main event (30.07.1974, 05:12:40, Lat.36.35^0, Long.70.76^0, Mb7.4). The right-hand figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. All the 11 events including the main event faithfully follow the straight-line curve.

Fig. 17 provides a 24-hour plot for thirty consecutive days including two main events (14.11.1974, 16:47:33, 15:56:34). The right-hand figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. All the 96 events including the main events faithfully follow the straight-line curve. For all these plots (right-hand plots in Figures 11-16), for 00 hrs GMT, the earthquake commences on the X axis (EMD+SEM) at the mean position of the longitude range (of the area under study). Also since in all these six cases the aftershocks occurred in a very small segment of latitudes and longitudes, this has resulted in the plot having a very narrow line.

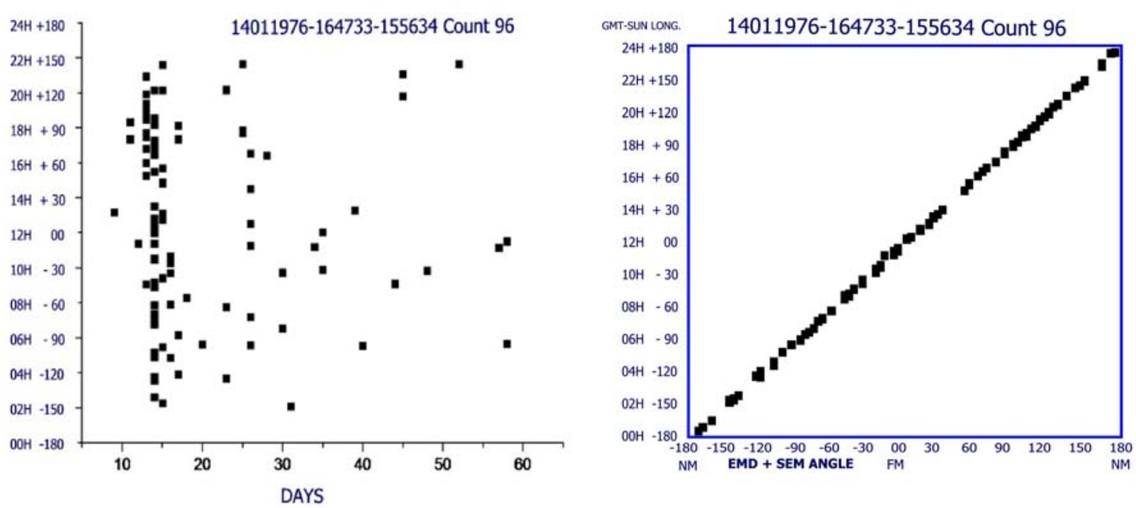

Fig. 17. The left-hand figure provides a 24-hour plot for thirty consecutive days including two main events (14.01.1976, 15:56:34 (Mb 8.2) 16:47:33(Mb 7.8), Lat -28.43^0, Long.-177^0). The right-hand figure provides an earthquake plot for (EMD+SEM) vs GMT timings for the same data. All the 96 events including the main events faithfully follow the straight-line curve.

Discussion and conclusions

During our earlier study of the effect of Earth tides on the occurrence of earthquakes (Kolvankar et al., 2010), we arrived at the findings listed below:

1. Earth tides trigger earthquakes at all depths and up to magnitude 5.0.
2. The lateral stresses applied during Earth tides close to the full Moon phase are more effective than the Earth-tide stresses during the new Moon phase.
3. Earthquakes of magnitude up to 3.0 and at a shallow-focus depth range of up to 10 km are triggered directly by the combined pull of the Moon and Sun. However in some areas even earthquakes in the higher magnitude ranges (typically 3-5) at shallow depth up to 10 km are triggered by the combined pull of the Moon and Sun.
4. The Mod indices (measure of high EQ count in small areas with regard to background) for small and shallow-focus earthquakes triggered by the combined pull of the Moon and Sun are much higher compared to the earthquakes triggered by lateral stresses close to the full Moon phase.
5. A study conducted for one of the high-seismicity areas utilizing the patterns of earthquakes triggered by Earth tides, obtained for consecutive periods, provides a good idea of the stresses built up periodically prior to major earthquakes.
6. Foreshocks and aftershocks of major events were found to align in a column representing a range of SEM angles. Most foreshocks form an EQ peak, which generally has the shape of a triangle with a different height depending on the EQ count. The response on either side of this SEM angle reduces, resulting in the formation of an isosceles triangle representing a rise in EQ counts. For the aftershocks, this column might continue in the foreshock column or shift to the adjacent column or any other column depending on the changes in the geometry and orientation of the fault where the major earthquake occurred.

During this study we also noticed that the Sun position in terms of universal time (GMT) has some links to the Earthquake-Moon distance (EMD) together with Sun-Earth-Moon (SEM) angle. In this paper we explored all the features of this relationship. It is astonishing to see that over 98% of worldwide earthquakes faithfully follow the straight-line relationship between the Sun position or GMT timings with (EMD+SEM). This proves beyond any doubt that the vast majority (98%) of worldwide earthquakes are governed by the Sun and Moon. Even the smaller earthquakes in the magnitude range of 2-3 faithfully follow this relationship. It is also seen that numerous aftershocks, which follow any major earthquake, faithfully follow straight-line curves, generated by the plot for (EMD+SEM) vs GMT timings. For all the plots providing earthquake data, for 00 hours GMT, the earthquake commences at the mean position of the longitude range (of the area under study) on the X axis (EMD+SEM).

It is seen that for plots for longitude ranges close to +/- 180^0, the earthquake plot occupies the central strip running diagonally from the origin of the plot. For all other plots, for 00 hours GMT, the earthquake commences at the mean longitude of the area under study, for the Sun's position opposite the earthquake region (180^0 out of phase).

Basically it is seen that all these earthquakes are triggered by the Earth tides caused by the positions of the Sun and the Moon and this process seems to be the primary triggering mechanism for all worldwide earthquakes. This includes deep-focus earthquakes, which are affected by Earth tides as shown by the earlier study (Kolvankar et al., 2010).

Acknowledgements: After the publication of our earlier paper on "Earth tides and earthquakes", the author had some discussion about the access database management of over five hundred thousand earthquakes. Mr Rahul Kesarkar demonstrated various aspects of the access database software. During this time, we became aware of the relationship between the GMT timings and the EMD + SEM. I wholeheartedly thank Mr Rahul Kesarkar for his efforts, which brought the relationship between these two parameters to our notice. I am also thankful to Mr. Sandeep Chaudhari for his kind help in database management and in plotting the graphs and to Dr. R. S. Chaughule and Dr. David Pratt for his thorough revision of the manuscript.

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SHORT NOTES

UNUSUAL EARTHQUAKE PATTERNS IN CHILE

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Abstract: Analysis of seismicity in Central Chile, over the last decade, demonstrates: - i) Conditions appear to be more complex than in the South West Pacific where Claude Blot developed his seismic energy transmigration model. ii) The plethora of after-shocks associated with major events suggests that extensive areas of coastal Chile (west of the Andes) exist under conditions of high stress. iii) A lack of seismicity under the high spine of the Andes is also to be found under the high Andes of Peru and the high Himalayas of Kashmir and western Tibet; an explanation for this phenomenon is proffered. iv) The volcanic eruption of Puyehue (June 2011) appears to exhibit only minimal connection with the preceding seismicity of the Conception region.

***Keywords**: earthquake patterns, Chile, earthquake prediction, fold mountain aseismicity, volcanic eruption precursors*

1. INTRODUCTION

In the first half of 2010, following the disastrous event at Conception on 27 February, the writer made a public prediction regarding further earthquake activity in Chile, published in NCGT #57, namely:

- Large shallow earthquakes in both the Coquimbo and Santiago areas, either late in 2010 or in the first half of 2011;
- Volcanic eruption(s) to the south-southeast of Conception.

These individual predictions were loosely based on the original Blot model of seismic energy transmigration developed in the south-west Pacific, Grover (1998), Blot, Choi & Grover (2005). However, in making the predictions, insufficient cognizance appears to have been taken by this writer of the possibility that things might not be so straightforward in a continental environment. Admittedly, a number of M≥5 earthquakes did occur as described above: two events very near Coquimbo in January 2011 and several of similar magnitude close to Santiago, also in the first part of 2011. These nonetheless appeared to be little more than the normal activity in either region over the past few years. The well-publicised eruption of Puyehue Volcano, in June 2011 - after fifty years of quiescence - might also be cited as some confirmation of the above predictions, except that Puyehue lies some 400 km to the south-southeast Conception, and there are several other closer volcanoes that did not stir. This point will be taken up again later. In view of the questionable value of the writer's 2010 predictions, it was considered that further analysis of the nature of seismicity activity in central Chile should be assessed over, say, the past decade.

2. REASSESSMENT

2.1 Earthquake patterns

Through http://neic.usgs.gov, earthquake results (M≥5) for the years 2000 to 2010 were obtained and plotted on a depth-time graph as used by Blot, **Figure 1**. What could be identified as the likely precursors to the disastrous earthquake at Conception are indicated on the figure: two M≥6 events in the deep earthquake zone under Argentina, in the latter part of 2007. These could be tentatively linked to two M≥5 events just to the north east of Conception in 2009: one at 90 km depth on 4 January; one at 63 km depth on 21 April. These two events are also marked on **Figure 2**, and their locations and depths fit reasonably well with rates of seismic energy transmigration formulated by Blot. However, neither of the events could be said to give any inkling of the size of the subsequent earthquake at Conception, which is the obvious role of prediction.

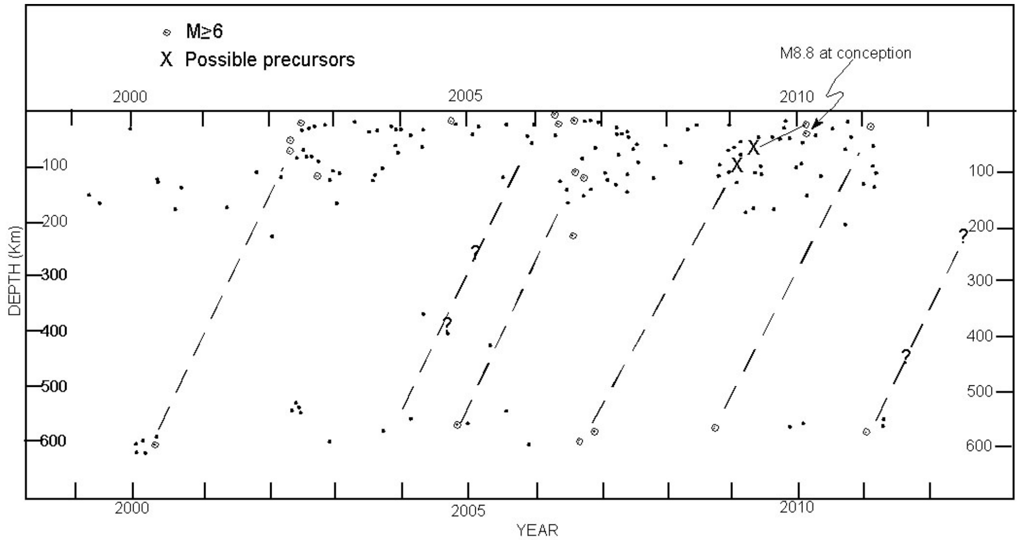

Figure 1. Time - depths plot for M≥5 earthquakes, central Chile, (Lat 20-40°S, Long 62 - 73° W)

The decade of seismic records were then plotted separately for each year on a flat Mercator-type plan. Little significant change in activity, on the Pacific side of the Andes, was apparent until 2007-2008 when a pronounced southerly migration of shallow seismic activity took place towards Conception, particularly in 2009. This is shown by grouping of events, on **Figure 2**.

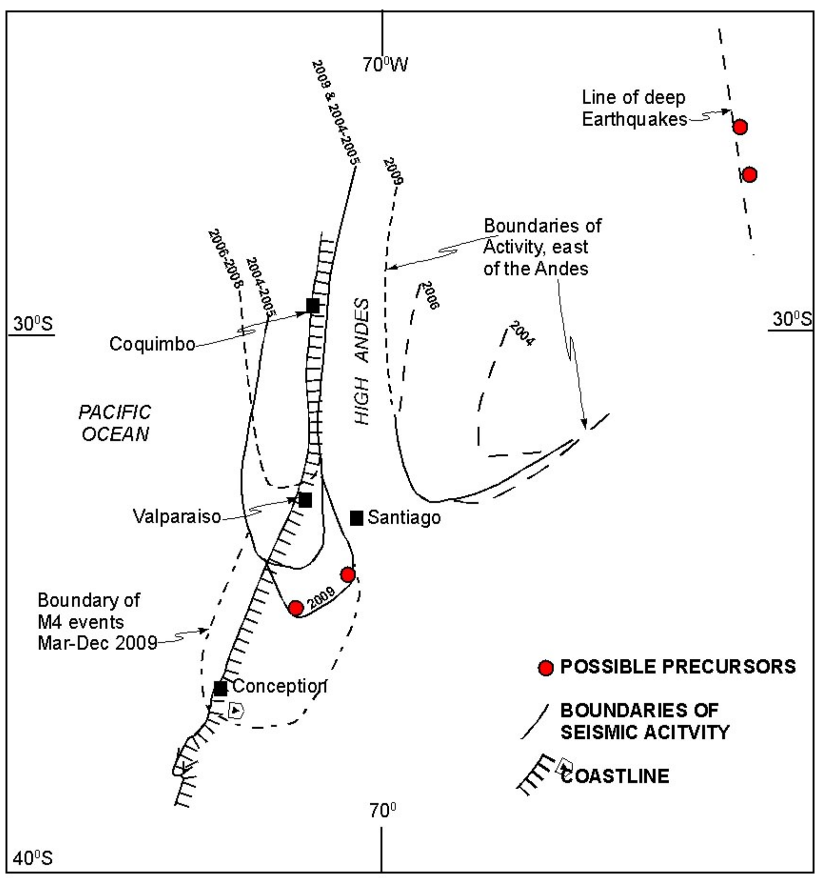

Figure 2. Summary of seismic activity M≥5, 2004-2009

To this point the survey had been restricted to M≥5 events. In order to check this whether this introduced any bias, the same survey parameters were run for shallow events of Magnitude M2.5 to M5 over the past several years. The main outcome of this was to confirm the southerly migration of seismic energy in 2009, when events of Magnitude M4 - M5 reached as far south as Conception, Figure 2.

The numbers of recorded events along the Pacific coastal zone, during this decade, were also plotted, per year, in **Figure 3**. A peak of activity for the lower magnitude events came during the year 2008. The huge numbers of M≥5 events in 2010 were largely produced on the day of major M8.8 event at Conception and within a day or two following this. Between the two peaks, there is a delay of one to two years. On a transmigration-of-seismic-energy basis, the length of this delay would tend to imply, on first impression, that there was no direct connection between the peaks. In any event, the lower Magnitude peak in 2008 would probably not have been seen as cause enough to predict the size of the coming M8.8 event. Nor, of course, was the huge swarm of M5 to M7 events in 2010 of any predictive value, since these earthquakes all came after the major earthquake. The area of "after-shocks" is shown on **Figure 4**.

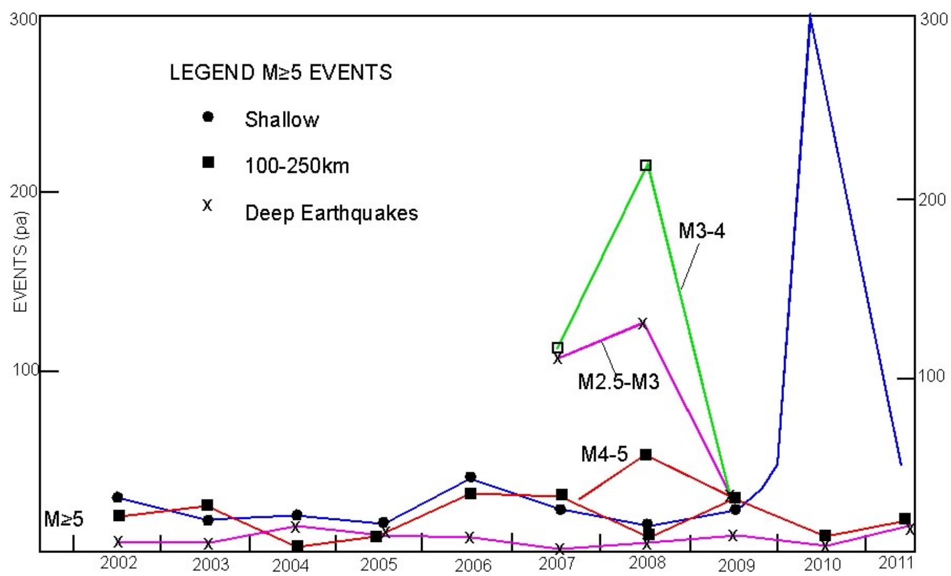

Figure 3. Events per year (lat. 26-40^0, Long. 62-73^0)

Pertinent here is the fact that huge swarms of after-shocks are not unusual along the coast of Chile. Some other examples:

- In July-August 1995, a swarm of shallow M ≥ 5 events followed an M8 earthquake at Lat. 23.3, Long. 70.3 degrees (near Antofagasta)
- In April 2006, a smaller swarm followed an M = 6.7 event in an area of Lat. 27 – 28 degrees, Long.70 degrees (150 km north of Coquimbo)
- In February 2011, a swarm of M 4 – 5 events followed an M = 6.8 event in the Conception region.

Such a pattern, where a large earthquake sets off a swarm of major after-shocks, suggests that the rock mass throughout the after-shock zone must already have been highly stressed, to a point approaching limiting equilibrium. Some further words on how this might occur are given later. The unfortunate aspect of such a pattern, as already mooted, is that it gives no early warning of the major event to come, because it is the major event that sets off the earthquake swarm. On the other hand, a major event could be seen as a likely precursor to an uncomfortable series of after-shocks.

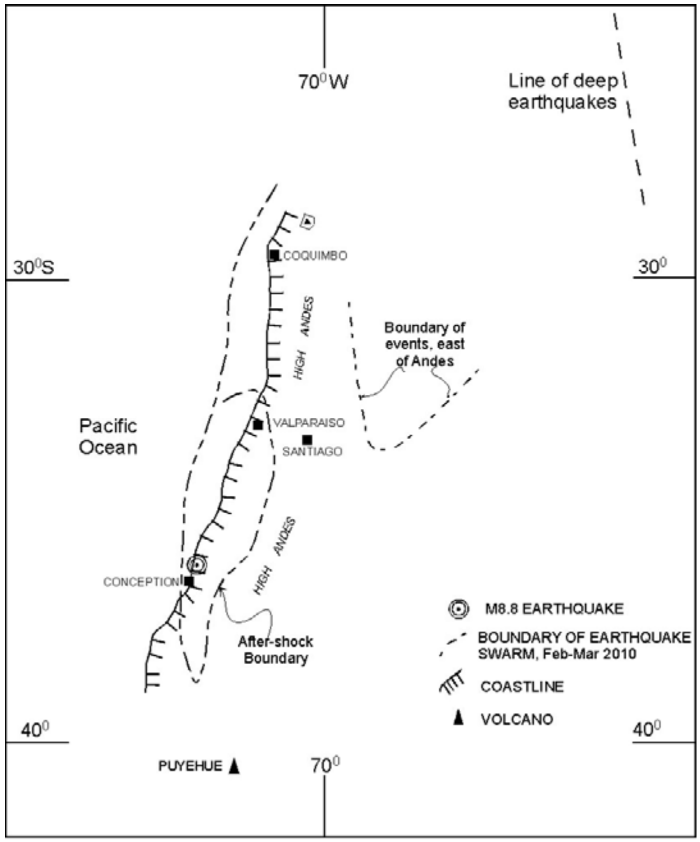

Figure 4 Boundary of seismic activity following M8.8 event, 27/2/10

In summary, reliable early warning indicators of a major earthquake at Conception are not obvious, or at least the indicators appear to be more complex than in the south west Pacific where Blot did his original work.

On the Atlantic (eastern) side of the Andes, earthquake activity is typically deeper (100 – 250 km depth) than on the Pacific side, but – apart from the events mentioned earlier - a similar lack of precursor signals can be inferred from the recorded activity. However, one surprising feature did emerge from this preliminary study: an almost complete lack of seismicity beneath the spine of the Andes. This raised the question of whether the aseismicity beneath the high Andes is a pattern recorded elsewhere or whether it is a one-off phenomenon. Dealing with this matter requires a small diversion.

2.2 The effect of the Andes

A search was made of earthquake records immediately available to the writer, in other similar geomorphological terrains around the globe. The same aseismic trend was found to occur beneath the high Peruvian Andes, in east-west profiles between Lat. 6 and 11 degrees south. In the Himalayas, north-south sections, at Long. 78 degrees East (Kashmir) and Long. 81 degrees (western Tibet), also revealed a similar lack of earthquakes beneath the high zone.

Such a pattern therefore may be of significance and an attempt to explain it, using a combination of the Blot and the Geoid Tectonics models, is as follows.

The Blot model is one of upwardly-lateral transmigration of seismic energy, initiated by deep earthquakes (500 – 700 km depth). In the 1960s, Blot initially tied his model to the alleged subduction process. Today, a more logical interpretation – at least from the writer's point of view - is that deep earthquakes occur when high temperature/high pressure volatiles escape from the deeper levels of the mantle to cause some form of hydraulic fracture in the 500 – 700 km depth range. The hydraulic fracturing process allows the volatiles to continue their upward migration. On encountering the Benioff zones, the high temperature/high pressure volatiles then act in conjunction with horizontal geoid stresses to produce an upward progression of shear failures (earthquakes). Incidentally, during this process, the volatiles no doubt suffer a gradual loss of both temperature and pressure. But it is this progression of seismicity up well-defined Benioff zones that allowed Blot to make such successful predictions of earthquakes and volcanic eruptions in the southwest Pacific and elsewhere. The geoid stress justification for this earthquake activity on the Benioff zones has been published by the writer in the pages of the NCGT, notably in issues #50 and #51.

Unfortunately, in Chile, earthquake patterns are less well defined than in the south-west Pacific although deep and the medium depth events are largely confined to the eastern side of the Andes, and shallow activity typically restricted to the western side, along the Pacific coastline. Now, the "roots" of the intervening Andes, as for most fold mountains, may extend to 30 - 35 km depth, but this depth should pose no real impediment to the migration of volatiles from one side of the Andes to the other. So, if such migration is taking place beneath the high spine of the Andes, why the loss of seismic activity?

Taking conditions at, say, 30 km depth, we have a vertical loading (in terms of effective stress) of approximately $\sigma_v' = 6 - 7 \times 10^5$ kPa. In a compression zone, such as with any fold mountain system, the horizontal stress can be expected to exceed the vertical stress by, say, the value of the geoid stress, perhaps by a modest 1×10^5 kPa. This insitu condition is illustrated by a Mohr circle, Circle A on **Figure 5**. The effect of volatile pressures now needs to be introduced; at any depth the volatile pressure could have a value almost up to the value of the vertical stress. The function of this excess pressure is to displace the Mohr Circle A to the left. Where the volatile pressure is high enough, the circle can be displaced far enough to cut the failure envelope for some favourably orientated discontinuity set: hence an earthquake. This failure situation is shown as Circle B on the figure, with a failure envelope drawn for an angle of friction along the discontinuity of 20 degrees.

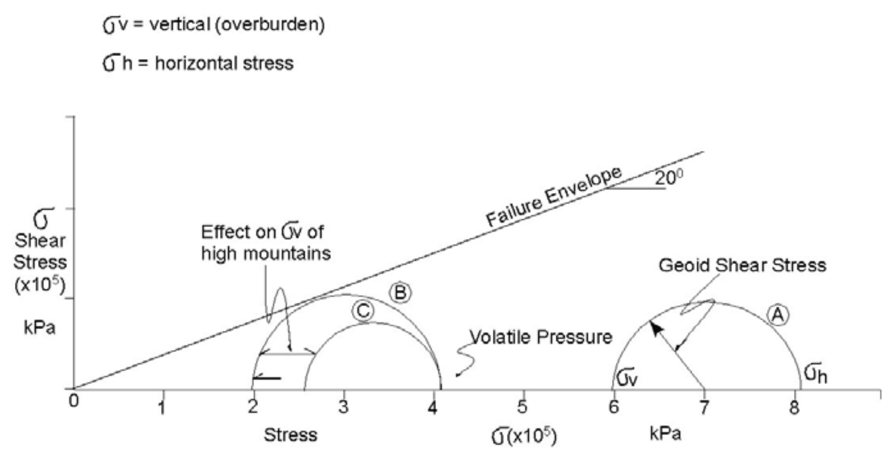

Figure 5 Effect on vertical (overburden) stress of high mountain chain

If the migrating volatiles pass beneath a high mountain range, as postulated, they will encounter a fairly abrupt increase in vertical stress under the increase in surface elevation. For a 5000m high range, the increase in vertical loading would approach 1×10^5 kPa in the upper levels of the crust. In the case of a thin mountain chain, this value might be taken to reduce slightly with depth. If we assume a reduction of 30% by 30 km depth, the increase in vertical stress beneath the mountain chain would be of the order of 0.7×10^5 kPa. Now, assuming this increase in vertical stress is associated with little change in semi-infinite horizontal stresses, the result would be a reduction in insitu shear stress, as shown by the smaller diameter Circle C. Circle C now lies below the failure envelope and therefore a failure (earthquake) does not take place: hence asesimicity beneath the high spine of the Andes. When the migrating volatiles pass beyond the mountain chain and the vertical stress drops, shear stresses increase once more and earthquake activity is once again generated.

2.3 The volcanic eruption

As Claude Blot discovered, a volcanic eruption is to be expected after large Magnitude, shallow, earthquakes. In the south-west Pacific, the pattern of precursors was consistent enough to allow him to make reliable long-term predictions of coming eruptions and similar interpretations have subsequently been made elsewhere in the world, in submissions to the NCGT by Blot and the Newsletter's editor, et al.

In Chile, however, the nexus between the recent large earthquake and the more recent volcanic eruption is not entirely clear. Admittedly, following the M8.8 event and the after-shock swarm, there was migration of seismic energy to the south south-east of Conception, towards Puyehue, but this was followed by attenuation in the numbers of events in the second half of 2010 - even a lull during the first half of 2011, when only two earthquake events in the immediate vicinity of Puyehue were recorded: one in April, one in May, both being of Magnitude M4. Neither event was seen as the cause for any alarm. Then, without warning, on 4 June, a swarm of eleven M4 earthquakes and countless smaller ones hit the Puyehue location, these being confined to an east-west rectangular area some 15 km by 75 km. Not long after, on that same day, the volcano erupted.

3. SOME INFERENCES

In Chile, the onset of major earthquake swarms, following immediately on the heels of a large Magnitude event, suggests that the zones of the swarms must have already been highly stressed prior to the large earthquake. Thus, when the system is shaken by a large earthquake, the ambient rock mass becomes shattered, reducing its overall shear strength and probably making it easier for any high pressure volatiles to migrate. As failure in one location takes place, in situ stresses may be reduced locally but some stress transference to adjacent locations is to be expected. Hence, ambient areas also undergo failure. Incidentally, this situation is sometimes noted after the onset of reservoir induced seismicity, James (2000), an activity that is initially caused by what is essentially a localised and minor change in pore pressures beneath a reservoir.

Along the coastline of central Chile, the swarm events have been of reasonably high Magnitude and have also been spread over quite extensive areas. Taking cognizance of the pore pressure factor, an inference could be made that the swarm areas might be areas of volatile accumulation. That is, under the pressure increments induced by this accumulation, the system approaches a critical stage, when all it needs is some triggering factor to put the whole zone into failure mode.

As suggested above, there is not a great deal in this short history to point to the potential here for straight forward, long-range forecasting, but it would be pleasing if some researcher were able to look into this matter in greater detail and perhaps come up with a more optimistic rationale. For instance, a prediction tool might be revealed through closer scrutiny of the low Magnitude data and/or the quantitative application of other plausible failure mechanisms that earth scientists are now pursuing and publishing in these pages. It might also be useful to have, in addition to the records of earthquake activity, some monitoring of phenomena such as insitu stresses and pore pressures to several kilometres depth in critical areas of the Earth's crust. Such information would require cooperation at a government level but it could be helpful in solving some of the existing contentious issues relating to earthquake behaviour.

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TWISTED SHEAR

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Abstract: Analysis of diagonal shear strain lines observed at the surface of the Earth, Moon, other planets, and their satellites. Significant number of structural features of the Earth and planetary satellites appear to follow a defined matrix of linear trends when viewed in Mercator projection. The patterns appear to be hierarchical, in that they can be repeatedly subdivided into smaller elements that retain the same configuration, or fractal pattern.

Keywords: *shear lines, double matrix, planets, satellites, asteroid impact, earthquake*

Introduction

The material presented in this article is designed to bring together an overall picture of our globe. It supplements my 1990 book, *The Twisted Earth*, which examines formations in the Pacific Ocean, major rivers, Hawaiian Islands, and Stonehenge, along with planetary satellites. *The Twisted Earth* is extensive, with many complete diagrams and maps, and a full explanation of each.

Directional system

The globe illustrated here (**Fig. 1**) shows a different geographical format than we commonly use: the map projections are cylindrical, and are crossed with oblique shear lines. The apex revolves around the equal intervals of N50E and N40W. Two other intervals describe projections of East and West, separated by 7 degrees North, and also separated by 2 degrees South. Shear lines cross a matrix of the entire Earth, separating N50E and N40W oblique lines.

The North American system is coincident with the Queen Elizabeth Island chain in the Arctic, along with the Canadian Lakes, Hudson Bay, and the coastal lines of the west. In South America, the southern system is coincident with the Chile extension. In Russia, the Arctic system is coincident with the Severnaya Zemlya Island chain, and on the west coast of Europe a stair step perimeter runs from Spain in the south to Taymyr in the Arctic north. The central system in the north describes a double mountain chain moving south from Asia to Africa, and in the west to Walvis. The shear lines within the globe all coincide with the N50E and N40W directionals, defining formations in both the oceans and continents. It is interesting to note that the orbital inclination to the Sun is approximately 7 degrees, the same as the degree of the North matrix system.

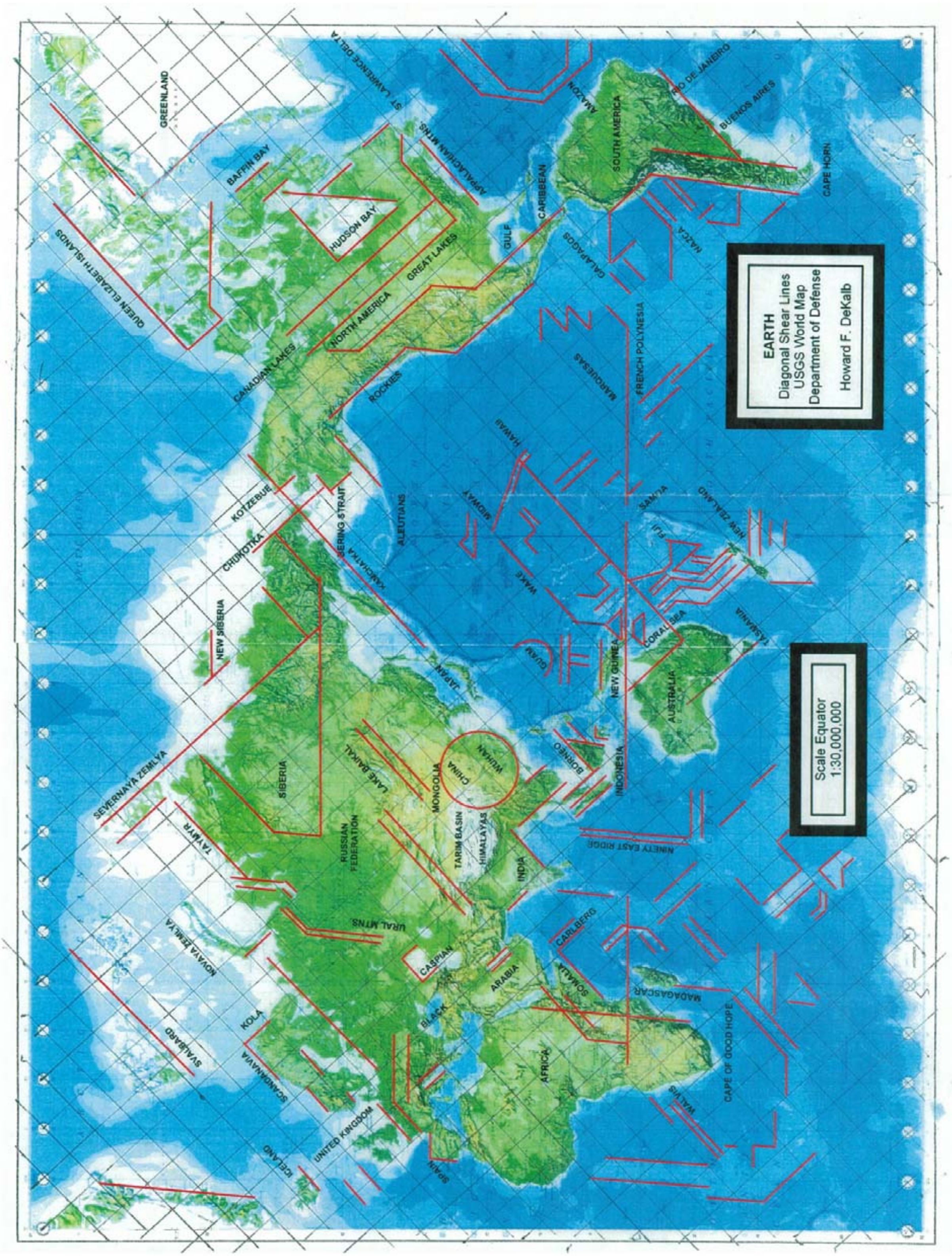

Figure 1. Diagonal shear lines of the Earth. A possible impact structure is seen in Wuhan, China.

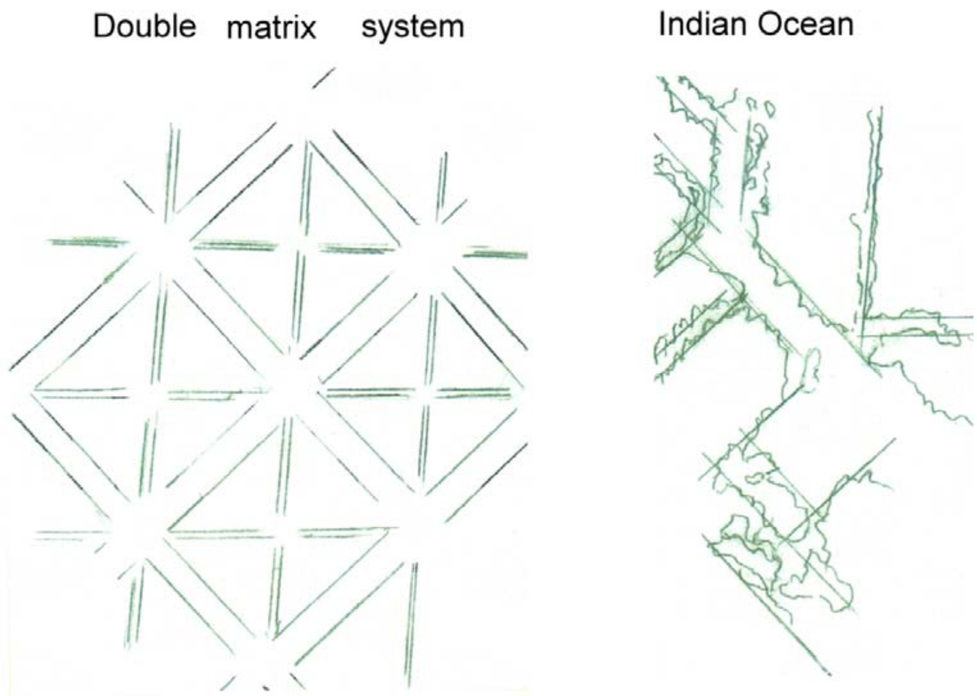

Figure 2. Shear outline elements. Double matrix system on left; application to formations in the Indian Ocean on right.

Detailed examples

Illustrated below (**Figs. 3 and 4**) are 24 detailed examples of shear lines defining both geologic formations on Earth and planetary satellite formations. All show evidence of shear lines within the N50E and N40W directions.

Jupiter Europa and New Madrid Seismic Zone

The following map (**Fig. 5**) is an overlay of the Jupiter Europa system and the New Madrid Seismic Zone system. The upper surface of satellite Jupiter Europa is made entirely of ice and is as smooth as a billiard ball. It is covered with an intricate network of intersecting lines. They cross the prominent Asterius Linea, and follow the N50E shear line directions for more than 1500 miles. The Jupiter Europa diagram (in gray) shows a sketch of the central portion, including both N50E and N40W lines. These, again, generally follow the 24 line directions described above.

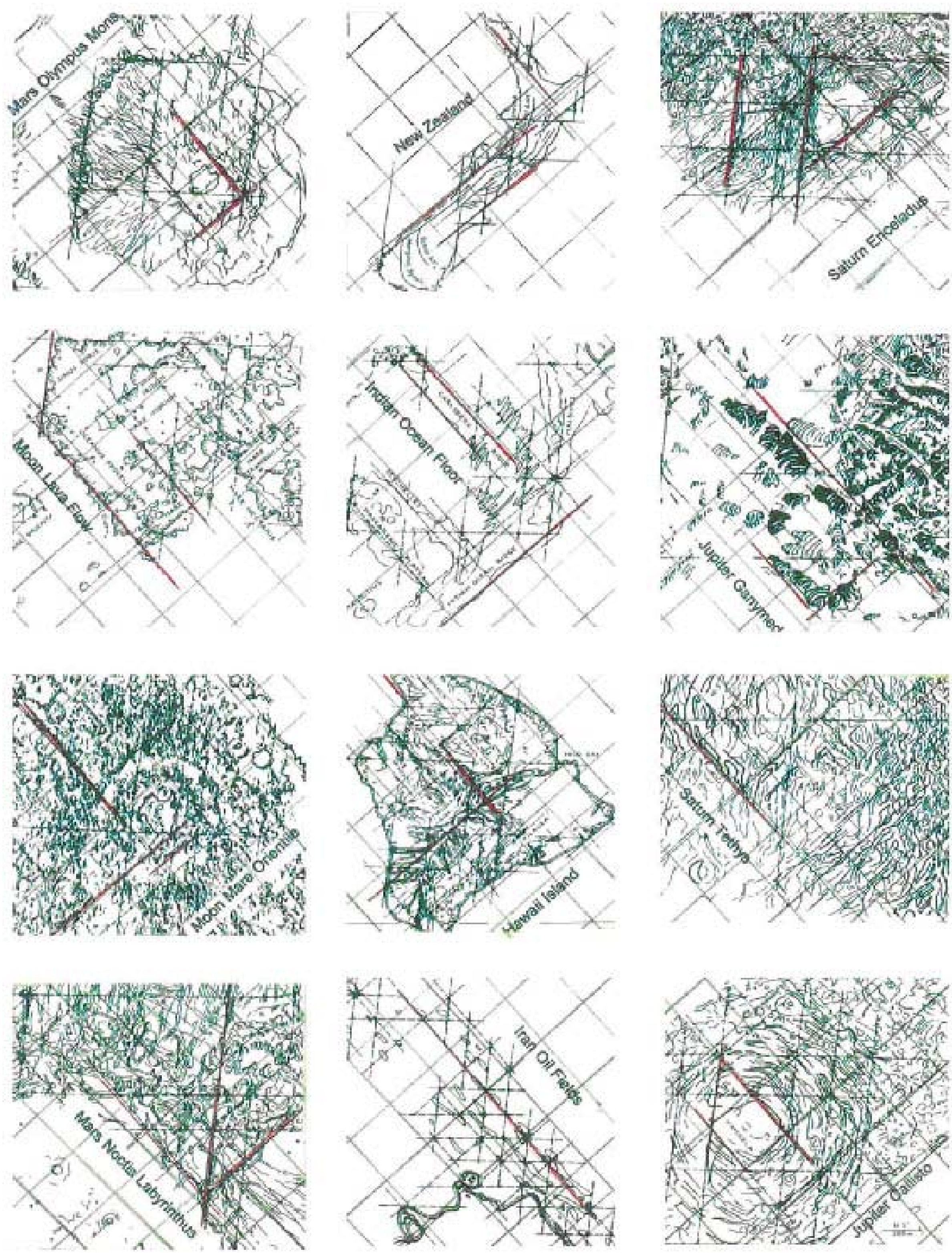

Figure 3. Diagonal shear lines observed on the Earth's surface, the Moon, other planets, and their satellites.

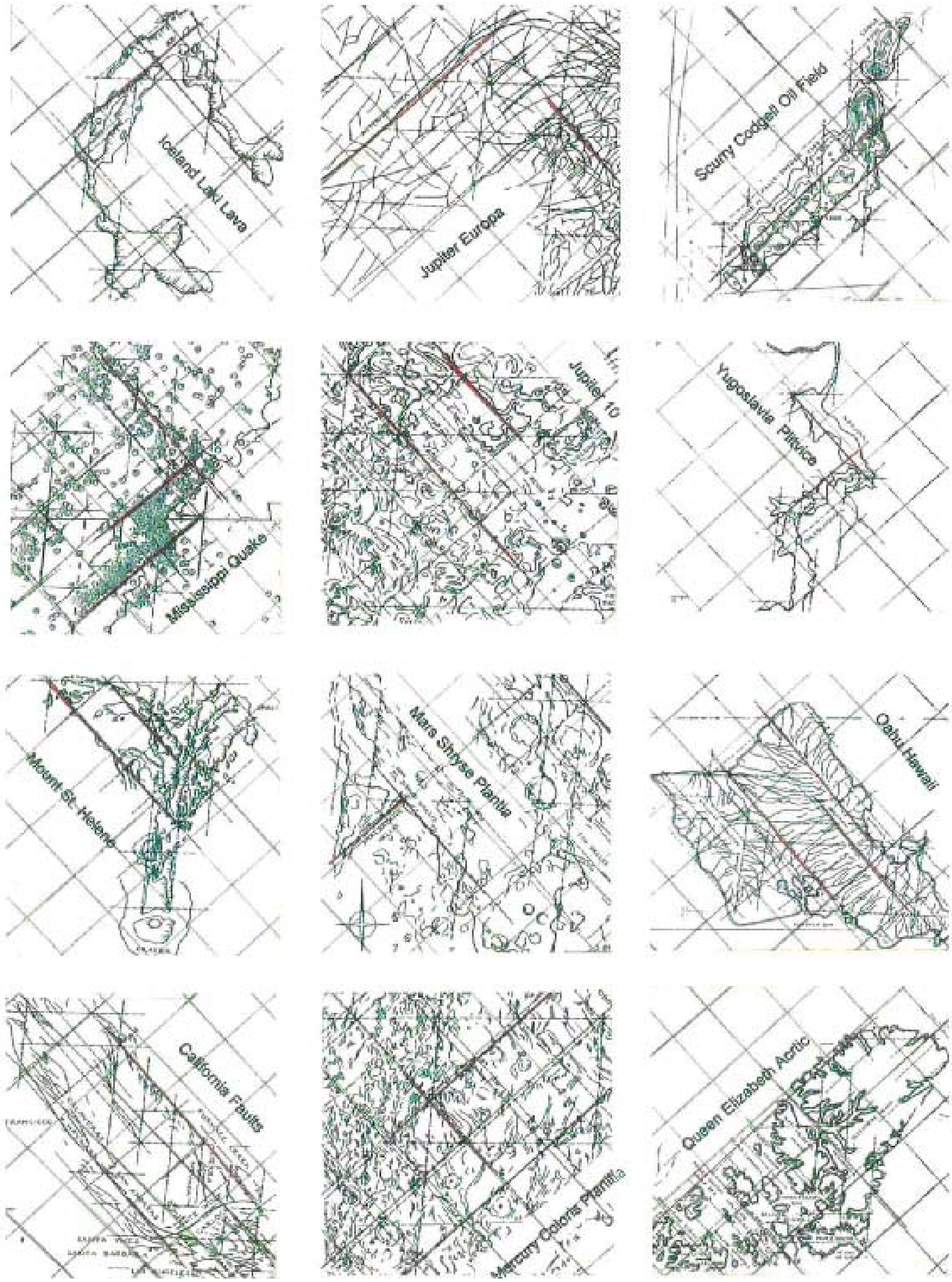

Figure 4. Diagonal shear lines observed on the Earth's surface, other planets, and their satellites.

On the New Madrid diagram (in black), the red symbols show earthquake events from the seismic records of the Mississippi and Ohio Rivers during the period of 1974-1997. This is the area that experienced the largest earthquake ever recorded within the United States, located near New Madrid, Missouri, in 1811-1812. The quake was felt as far as the U.S. East Coast and Montreal, Canada. There was shaking on and off for as much as a year and more, with three quakes of estimated magnitude 8 on the Richter scale. The diagram shows a straight line broken over N50E, and then generally, a second straight line over N40W. The discontinuities and abrupt straight lines are common over the 24 examples previously illustrated.

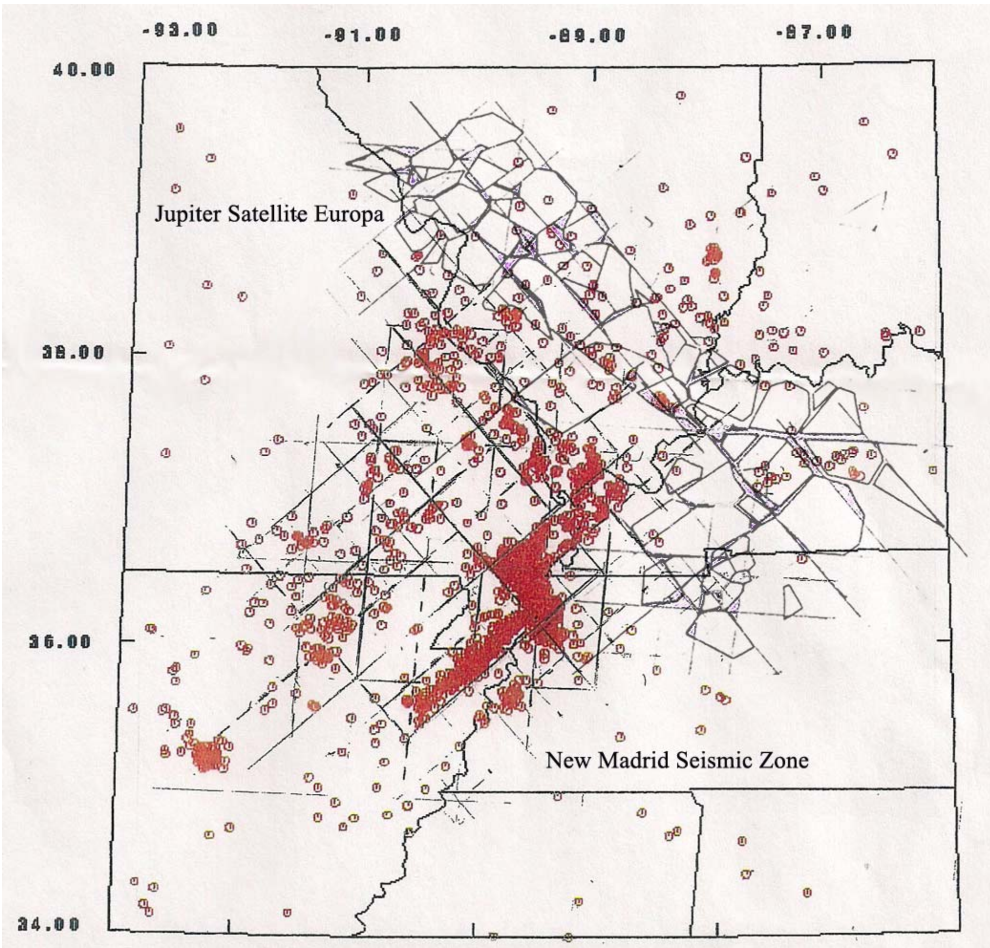

Figure 5. Jupiter Satellite Europa and New Madrid Seismic Zone systems.

Impact results

Luann Becker, quoted in *Scientific American,* states that 250 million years ago, a large object may have collided with the Earth on the east coast of China near Wuhan. The impact created a large circular area, and may have destroyed a portion of the Permian Meishan formation. As much as 90 percent of life could have disappeared at that time. This event would have blacked out the sun, triggering lava flows, volcanoes and explosions on both land and ocean.

Something similar may have happened on the planet Jupiter in 1994, when the comet P/Shoemaker-Levy 9 collided spectacularly with the planet, and was torn apart. This was extensively observed by ground and space-based telescopes, as it fell through the clouds of Jupiter and exploded with the impact into fragments. Since Jupiter is completely covered with haze, the impact itself could not be seen, but lightning from the dying collision showed the effects. As is true of any large impact, including those on our own planet, it scattered debris across a wide area. A similar event could have formed the many islands, deep trenches, and ruptured continental breaks within South Asia.

Conclusions

This material is based on observations developed over many years, primarily that a significant number of structural features of the Earth and planetary satellites appear to follow a defined matrix of linear trends when viewed in Mercator projection (**Fig. 1**). The pattern also appears to be hierarchical, in that it can be repeatedly subdivided into smaller elements that retain the same configuration (**Figs. 3 and 4**). Possible effects of asteroid impacts on geologic formations are also taken into account.

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GEOPOLITICAL CORNER

CORRUPTION OF SCIENCE IN AMERICA

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"That man will be very fortunate who, led by some unusual inner light, shall be able to turn from the dark and confused labyrinths within which he might have gone forever wandering with the crowd and becoming ever more entangled. Therefore, in the matter of philosophy, I consider it not very sound to judge a man's opinion by the number of his followers."

- Galileo Galilei, The Assayer (1623)

Truth is the pillar of civilization. The word 'truth' occurs 224 times in the King James Version of the Holy Bible; witnesses testifying in American courts and before the United States Congress must swear to tell the truth; and, laws and civil codes require truth in advertising and in business practices, to list just a few examples.

The purpose of science is to discover the true nature of Earth and Universe and to convey that knowledge truthfully to people everywhere. Science gives birth to technology that makes our lives easier and better. Science improves our health and enables us to see our world in ways never before envisioned. It uplifts spirits and engenders optimism. And, science provides a truth standard, securely anchored in the properties of matter, a means to expose and debunk the charlatans and science-barbarians who would lie, cheat, steal, and tyrannize under the guise of science.

Prior to World War II there was little government financial support for science. Nevertheless, the 20th century opened and seemed to offer the promise of an unparalleled age of enlightenment and reason.

While supporting himself as a Swiss patent clerk, Albert Einstein explained Brownian motion, the photoelectric effect, and special relativity. Niels Bohr, supported by grants from the Carlsberg Brewery, made fundamental discoveries about atomic structure and served as a focal point and driving force for the collaborative effort that yielded quantum mechanics, the field of science underpinning the solid state electronics technology that makes possible modern communications and computers. For a time, the meanings of new observations were actively debated. Fertile imaginations put forth ideas that challenged prevailing views. New ideas and new understandings began to emerge, sometimes precise, sometimes flawed, but tending toward truth and inspiring more new ideas and inspiring yet further debate. Individual imagination and creativity, driven by the quest for a true understanding of the nature of Earth and Universe, produced a sense of enthusiasm and excitement; new insights and discoveries enlightened the general public and kindled the imaginations of the young. An air of optimism prevailed.

Although money for science at the time was in short supply, scientists maintained a kind of self-discipline. A graduate student working on a Ph.D. degree was expected to make a new discovery to earn that degree, even if it meant starting over after years of work because someone else made the discovery first. Self-discipline was also part of the scientific publication system. Prior to World War II, when a scientist wanted to publish a paper, the scientist would send it to the editor of a scholarly journal for publication and generally it would be published. A new, unpublished scientist was required to obtain the endorsement of a published scientist before submitting a manuscript. The concept of 'peer review' had not yet been born.

But in the final decades of the 20th century, circumstances began to change. On one hand, outwardly, it seemed we were poised for yet another renaissance, with ready access to powerful new computers, satellite imaging, network data systems, and global communications. But, on the other hand, out of sight and unknown to nearly everyone, something had gone seriously wrong. Beneath the surface lay the foundations of a system which had been corrupted and had evolved to support a 'politically correct' consensus view of Earth and Universe, while tending to discourage, ignore, stifle and suppress advances and challenges by individuals.

Before World War II, there was very little government funding of science, but that changed because of war-time necessities. In 1951, the U.S. *National Science Foundation* (NSF) was established to provide support for post World War II civilian scientific research. The process for administrating the government's science funding, invented in the early 1950s by NSF, has been adopted, essentially unchanged, by virtually all subsequent U.S. Government science funding agencies, such as the *National Aeronautics and Space Administration* (NASA) and the U.S. Department of Energy (DOE).

The problem, I discovered, is that the science funding process that the NSF invented and passed on to other U.S. Government agencies is seriously and fundamentally flawed. As a consequence, for more than half a century, the NSF has been doing what no foreign power or terrorist organization can do: slowly, imperceptibly undermining American scientific capability, driving America toward third-world status in science and in education, corrupting individuals and institutions, rewarding the deceitful and the institutions that they serve, stifling creative science, and infecting the whole scientific community with flawed anti-science practices based upon an unrealistic vision of human behavior. These are the principal flaws:

NSF Flaw #1: Proposals for scientific funding are generally reviewed by anonymous 'peer reviewers'. NSF invented the concept of 'peer review', where in a scientist's competitors would review and evaluate his/her/their proposal for funding, and the reviewers' identities would be concealed. The idea of using anonymous 'peer reviewers' must have seemed like an administrative stroke of genius because the process was adopted by virtually all government science funding agencies that followed and almost universally by editors of scientific journals. But no one seems to have considered the lessons of history with respect to secrecy. Secrecy is certainly necessary in matters of national security and defence. But in civilian science, does secrecy and the concomitant freedom from accountability really encourage truthfulness? If secrecy did in fact lead to greater truthfulness, secrecy would be put to great advantage in the courts. Courts have in fact employed secrecy – during the infamous Spanish Inquisition and in virtually every totalitarian dictatorship – and the result is always the same: unscrupulous individuals falsely denounce others and corruption abounds.

The application of anonymity and freedom from accountability in the 'peer review' system gives unfair advantage to those who would unjustly berate competitor's proposal for obtaining funding for research and for publishing research results. Anonymous 'peer review' has become the major science-suppression method of the science-barbarians. Moreover, the perception – real or imagined – that some individuals would do just that has had a chilling effect, forcing scientists to become defensive, adopting only the 'politically correct' consensus - approved viewpoint and refraining from discussing anything that might be considered a challenge to others' work or to the funding agency's programs. And that is not what science is about at all. Not surprisingly, there exists today a widespread perception that to challenge scientific results supported by a U.S. Government agency will lead to loss of one's own support.

NSF Flaw #2: NSF invented the concept of scientists proposing specific projects for funding, which has led to the trivialization and bureaucratization of science. Why so? The problem is that it is absolutely impossible to say beforehand what one will discover that has never before been discovered, and to say what one will do to discover it. The consequence has been the proposing of trivial projects with often non-scientific end-results, such as the widespread practice of making models based upon assumptions, instead of making discoveries. Further, bureaucrat 'program managers' decide which projects are suitable for the programs that they design. Moreover, proposal 'evaluation' is often a guise for 'program managers' and 'peer reviewers' to engage in exclusionary and ethically questionable, anti-competitive practices. There is no incentive for scientists to make important discoveries or to challenge existing ideas; quite the contrary.

NSF Flaw #3: NSF began the now widespread practice of making grants to universities and other non-profit institutions, with scientists, usually faculty members, now being classed as 'principal investigators'. The consequence of that methodology is that there is no direct legal responsibility or liability for the scientists' conduct. All too often scientists misrepresent with impunity the state of scientific knowledge and engage in anti-competitive practices, including the blacklisting of other capable, experienced scientists. University and institution administrators, when made aware of such conduct, in my experience, do nothing to correct it, having neither the expertise nor, with tenure, the perception of authority or responsibility. The result is that American tax payers' money is wasted on a grand scale and the science produced is greatly inferior to what it might be.

NSF Flaw #4: NSF began the now widespread practice whereby the government pays the publication costs, 'page charges', for scientific articles in journals run by for profit companies or by special interest science organizations. Because these publishers demand ownership of copy rights, taxpayers who want to obtain an electronic copy must pay, typically US$40, for an article whose underlying research and publication costs were already paid with taxpayer dollars. Moreover, commercial and protectionist practices often subvert the free exchange of information, which should be part of science, making the publication of contradictions and new advances extremely difficult.

Furthermore, publishers have little incentive or mechanism to insist upon truthful representations. For example, in ethical science, published contradictions should be cited, but with the extant system it is common practice to ignore contradictions that may call into question the validity of what is being published. The net result is that unethical scientists frequently deceive the general public and the scientific community, and waste tax payer-provided money on questionable endeavors.

I have described these four fundamental NSF instigated flaws that now pervade virtually all civilian U.S. Government-supported science funding, and have proposed practical ways to correct them,[1] which I communicated to two NSF directors, who chose to ignore them. There seems to be a widespread perception of intrinsic 'infallibility' in the government-university complex, where in any action, regardless of the seriousness of its adverse consequences, is considered beyond reproach.

On December 16, 2004, an individual in the White House to whom I had complained about the inequity of 'peer review' sent me a copy of the U.S. Office of Management and Budget's *Final Information Quality Bulletin for Peer Review: December 15, 2004*. On December 26, 2004, I sent to the White House my critique of that Bulletin and my recommendations for systemic changes, which were neither appreciated nor implemented.[2] Six years later, the U.S. Government still conducts 'peer review' according to that Bulletin, which: *(1*) Embodies the tacit assumption that 'peer reviewers' will always be truthful, and fails to provide any instruction, direction, or requirement either to guard against fraudulent 'peer review' or to prosecute those suspected of making untruthful reviews; *(2*) Approves the application of anonymity and even appears to promote some alleged virtue of its use, *"e.g., to encourage candor"*; *(3)* Gives tacit approval to circumstances that allow conflicts of interest and prevents the avoidance of conflicts of interest; and, *(4*) Fails to recognize or to admit the debilitating consequences of the long-term application of the practices it approves.

One consequence of NSF's invention of anonymous 'peer review' is that publication of scientific papers is often delayed for years or prevented by so-called 'peer reviews' from competitors, whose primary aim is to debilitate or eliminate their competition. In the 1990s, the National Science Foundation funded the development at Los Alamos National Laboratory of an author self-posting archive, where physicists and mathematicians could post their preprints, without interference from their competitors, making them available worldwide almost instantly. That archive underwent various name changes, eventually becoming *arXiv.org*.

Since its inception, *arXiv.org* has become the preeminent means of scientific communication in the areas of science and mathematics it hosts. Rather than wade through the many hundreds of individual scientific journals, often having limited access without paying fees, scientists can receive by email a list of daily postings in specific areas of the scientific disciplines hosted by *arXiv.org* and can download scientific articles of interest without charge. The development of the author self-posting archive might have become the jewel in NSF's crown, one of its greatest achievements. Instead, NSF's mal-administration permitted it to become an instrument for science suppression, and for blacklisting and discrimination against competent, well-- trained scientists worldwide.

On or about 2001, key personnel responsible for developing the author self-posting archive at Los Alamos National Laboratory left that organization to become employed by Cornell University. Presumably in a coordinated way, Cornell University, through a proposal to the National Science Foundation [NSF # 0132355, July 16, 2001], took over ownership of the author self-posting archive, now called *arXiv.org*, and presumably was given the requested US$958,798 to do that. That proposal contains the following statement made to justify Cornell University's proposed use of a 'refereeing mechanism': "*The research archives become less useful once they are inundated for example by submissions from vociferous 'amateurs' promoting their own perpetual motion machines.…*"

The website *archivefreedom.org* displays case histories of some of the individuals who have been blacklisted by the *arXiv.org* administration and its 'secret moderators', and includes a statement by blacklisted scientist and Nobel Laureate Brian D. Josephson explaining the meaning of blacklisting as applied to *arXiv.org*.[3] Being blacklisted by *arXiv.org* means that either your attempts to post scientific papers are disallowed, or they are 'buried', i.e., posted in categories where scientists or mathematicians in the specific area will likely not see them, such as in General Physics or in General Mathematics. The principal consequence of *arXiv.org* blacklisting is to deceive U.S. Government science funding officials and individuals conducting scientific investigations and teaching science, keeping them in the dark about new ideas and discoveries. Beyond the financial and professional debilitation suffered by blacklisted scientists and mathematicians, there is also a human toll, as on blacklisted individual noted: "*Blacklisted scientists are subject to derision, ignorance, insults, lies, false accusations, personal attacks against them, misrepresentations regarding their research, culture, faith, etc.*"

Hundreds of thousands of scientific papers have been posted on the author self-posting archive, *arXiv.org*, *without any* human intervention at all. Human intervention, but *no*t 'peer review', occurs *onl*y when an individual is 'denounced', intentionally singled out for disparate treatment, through the application of unfair, arbitrary, and capricious standards. Being tagged for disparate human intervention may occur for a number of never specified reasons. Human intervention is perpetrated by *arXiv.org* administrators in conspiracy with a small group of *arXiv.org* 'insiders' who may or may not call themselves 'moderators' and who discriminate in secret and without any accountability. Moreover, there is no recourse: in my experience, Cornell University's librarian, provost and president absolve themselves from any oversight responsibility for the conduct of *arXiv.org*, referring complaints back to the *arXiv.org* administrators who are the subject of the complaint in the first place. Being 'denounced' for disparate treatment by secret 'insiders', without recourse, is something I might have expected from the now-defunct Soviet Union or from Ceausescu's Romania. But, here it is in America; bought and paid for by the National Science Foundation. As an American citizen, veteran, and taxpayer, I am justifiably appalled!

In my view, there is something fundamentally wrong with Cornell University receiving U.S. Government grants and contracts to conduct scientific research, and then deceiving the scientific community, via *arXiv.org*, by not posting or by hiding new advances or contradictions, especially in instances that potentially impact the investigations being performed at government expense at Cornell. Cornell University is a recipient of millions of dollars in U.S. Government grants and contracts, and is one of a pool of competitors for Federal grants and contracts. The National Science Foundation, I submit, made an institutionally stupid blunder in turning over to Cornell University a powerful tool (*arXiv.org*) that could be used against its competitors. In doing so, I allege, the U.S. National Science Foundation violated the very law that created NSF:

"In exercising the authority and discharging the functions referred to in the foregoing subsections, it shall be an objective of the Foundation to strengthen research and education in the sciences and engineering, including independent research by individuals, throughout the United States, and to avoid undue concentration of such research and education." [42 United States Code 1862 (e)]

Instead of obeying that law, the U.S. National Science Foundation placed into the hands of one major, well-financed competitor a powerful tool (*arXiv.org*) which could not only be applied arbitrarily with capricious standards against its competitors, but through such actions would cast a shadow of fear at being 'denounced' in secret and there upon being blacklisted, further ensuring 'politically correct' consensus conformity and science suppression. So, what should be done?

In my view, the United States Congress should initiate an investigation into allegations of abuse and possible criminal activity in the acquisition and operation of *arXiv.org* at Cornell University, including the possibility of complicity and/or acquiescence by individuals at other universities and by other government entities, including the U.S. Department of Justice and the Attorney General of the State of New York. If evidence warrants, the United States Government, I believe, should consider initiating legal action to repossess *arXiv.org* and put it under aegis of a neutral, non-competitor organization, such as the National Archive or the Library of Congress, as should have been done initially.

The noted economist, George E. P. Box, said essentially this about models: all models are wrong, but some are useful. Generally, models set out to model some observable or hypothetical event or process and achieve the result they seek to obtain by making result-oriented assumptions and tweaking variables; those models do not have to be correct and can generally be replaced with other models. **To me, it is much more important to discover the true nature of Earth and Universe than to make such models.**

Astronomers have made some truly remarkable observations. Astrophysicists attempt to understand the physical basis underlying those observations by making models based upon assumptions or upon other models based on other assumptions. In the 1920s, scientists discovered thermonuclear fusion, the joining of two very light atomic nuclei with great energy release. The process is called 'thermonuclear' because temperatures of about one million degrees centigrade are required to ignite the reaction. In the 1930s, scientists worked out the thermonuclear reactions thought to power the Sun and other stars. The million-degree ignition temperature? It was assumed to be generated when dust and gas collapsed during their formation. But, as I realized later, there are serious impediments to attaining million degree temperatures in that manner.

A star is like a hydrogen bomb held together by gravity. The thermonuclear fusion reactions of all hydrogen bombs are ignited by small nuclear fission atomic bombs. In 1994, in a scientific paper published in the *Proceedings of the Royal Society of London*, I suggested that stars, like hydrogen bombs, are ignited by nuclear fission, the splitting of uranium and heavier atomic nuclei.[4] The implications are profound: stars are not necessarily ignited during formation, as previously thought, but require a fissionable trigger. My concept of the thermonuclear ignition of stars by nuclear fission has been completely ignored by the model making astrophysicists. Ignoring work that challenges the 'politically correct' consensus-approved storyline is common practice, thanks to the fear of retribution by secret 'peer reviewers' or to the fear of being 'denounced' and blacklisted.

In 2006, I submitted a short manuscript on the thermonuclear ignition of dark galaxies to *Astrophysical Journal Letters*. I signed the required copyright transfer form, and the manuscript went out for secret 'peer review', but it was rejected without any substantive scientific criticism. So I submitted two other brief, but important, manuscripts. The fact that I was never asked to sign the copyright transfer forms for those other two papers prior to review, as required, was clear indication that they were not going to be accorded the fair and impartial consideration that is supposed to be the usual policy of the American Astronomical Society, the journal's sponsor. Not surprisingly, those manuscripts were rejected without any scientifically valid justification. I complained to the officers of the American Astronomical Society, who never responded, even though the bylaws of the American Astronomical Society (*AAS*) clearly state: "*As a professional society, the AAS must provide an environment that encourages the free expression and exchange of scientific ideas*." In rejecting those manuscripts, the American Astronomical Society hid from its members, from the scientific community, and from U.S. Government science funding officials, fundamentally new insights about the Universe, including why galaxies have the characteristic appearances they are observed to have.[5]

Not long after the *Astrophysical Journal Letters* incident, I found myself blacklisted by *arXiv.org*. Before, I was not only permitted to post, but also to endorse others in the following categories: Astrophysics, Educational Physics, General Physics, Geophysics, History of Physics, and Space Physics. Now, for no legitimate reason, I am blacklisted, stripped of the ability to endorse others, and suffer having my scientific papers 'buried' in General Physics where it is unlikely they will be noticed; that is, if they are allowed to post at all. Even my scientific papers that call into question U.S. Government funded investigations at Cornell University are either 'buried' or forbidden to post in this author self-posting archive, *where hundreds of thousands of papers post automatically without human intervention.*

A half-century of the use of secret 'peer reviews' by competitors, at the National Science Foundation and at the other agencies which followed, such as NASA, has produced a 'never criticize the science' mentality among grant-recipients. But science is all about finding out what is wrong with present thinking and correcting it. American science education has been stunted by that mentality. Educational organizations which receive grants from NSF or NASA almost never teach students or teachers about work that challenges the 'politically correct' consensus approved storyline. The same goes for 'science news' organizations that rarely report the results of investigations that call into question the 'politically correct' story line. Institution-alized science-corruption is wide spread and pervasive in America, and the fallout is international; the 'Climategate' debacle is just one example.

At one time, scientists thought that planets do not produce energy, except small amounts from radioactive decay; planets just receive energy from the Sun and then radiate it back into space. Beginning in the late 1960s, astronomers observed that Jupiter, Saturn and Neptune radiate into space nearly twice the energy they receive from the Sun. For twenty years the source of that internal energy was a mystery to NASA-funded scientists, who wrongly thought they had considered and eliminated all possibilities. In1991, I submitted a scientific paper to the German *Naturwissenschaften* demonstrating the feasibility of that energy being produced by natural nuclear fission reactors at the planets' centers. I used the same approach that Paul K. Kuroda had used in1956 to predict the occurrence of natural nuclear reactors in ancient uranium mines, the fossil remains of which were discovered in 1972 at Oklo, in the Republic of Gabon.

When that paper was accepted for publication,[6] I submitted a research proposal to NASA's Planetary Geophysics Program. Paul K. Kuroda accepted my invitation to join in as a co-investigator. Kuroda, however, insisted that his efforts be *pro bono* as he '*did not nee*d *the money*'.

The Universities Space Research Association, an association of major institutional recipients of NASA funding, operates the Lunar and Planetary Institute, which operated the Lunar and Planetary Geoscience Review Panel (LPGRP) at the time I submitted the proposal. The LPGRP served NASA by soliciting secret 'peer reviews' of submitted proposals, then evaluating the proposals in secret session, based upon those 'peer reviews', and ranking them so as to make it easy for a NASA official to decide which to fund. The LPGRP, composed of a group of principal investigators of NASA grants, funded either through NASA's Planetary Geophysics Program or Planetary Geology Program, conducted the secret ranking of all proposals submitted to one or the other of those same two NASA programs. In other words, my proposal was competing for the same limited pool of funds as proposals from the very institutions whose personnel served on the LPGRP. At the time, the chairman of the LPGRP was as-sociated with NASA's Jet Propulsion Laboratory, which is operated by the California Institute of Technology (Caltech), and which consumed more than 40% of the budget of the Planetary Geophysics Program.

Needless to say, my proposal was not funded. Normally, the LPGRP's ranking of proposals is kept secret, but through extraordinary efforts I learned from the U.S. Congress' General Accounting Office (called the Government Accountability Office since 2004) that on technical merit the LPGRP ranked my proposal lowest of the120 proposals submitted to NASA's Planetary Geophysics Program. One might seriously question the integrity of that ranking, as I later independently performed all that I had proposed and much more, including demonstrating the feasibility of a nuclear fission reactor at the center of Earth, called the georeactor, as the energy source and production mechanism for the Earth's magnetic field.[4, 7, 11] I also extended the concept to other planets and large moons.[12] The concept of planetary nuclear fission reactors has received quite thorough vetting in the international scientific community. So, what was NASA's re-sponse?

In the twenty years that have passed since the proposal debacle, NASA-supported scientists, to my knowledge, have never mentioned natural nuclear fission reactors or cited my publications. But they have discussed numerous observations where they should have, instances of 'mysterious' internal heat production and magnetic field generation, such as: *(1)* Internal heat generation in Jupiter, Saturn and Neptune; *(2)* Our Moon having a soft or molten core; *(3)* Tiny planet Mercury having a magnetic field; *(4)* Mars displaying evidence of an ancient magnetic field; *(5)* Our Moon displaying evidence of an ancient magnetic field; *(6)* Jupiter's moon Ganymede having an internally generated magnetic field; *(7)* Saturn's moon Enceladus showing evidence of internal heating; and *(8)* Evidence of internal heat generation in Pluto's moon Charon. I receive numerous emails from people throughout the world who read NASA news reports and wonder why my work is not mentioned, when it would seem to provide plausible explanations.

In a manner no different from astrophysics, the American geophysical community consistently ignores my scientific challenges to the 1940 vintage thoughts that form the basis of their assumptionbased models. Science is *not* about telling one 'politically correct' story and ignoring everything else. Instead, science is about finding out what is wrong with existing ideas and correcting them. American geophysicists have wasted untold multimillions of tax-payer-provided dollars on totally worthless endeavors, instead of progressing in fruitful directions. I publish important, well-founded contradictions to current scientific thinking in world-class journals. It is the responsibility of an ethical scientific community to attempt to confirm or to refute the concepts presented. In any case, those contradictions should be cited.[13]

In 1936, Inge Lehmann discovered the inner core, an object at the center of Earth almost as large as the Moon and about three times as massive, that, since about 1940, was thought to be iron in the process of freezing. In 1979, I published an entirely different idea of the inner core's composition. The scientific paper was communicated by Nobel Laureate Harold C. Urey to the *Proceedings of the Royal Society of London*[14] and I received a complimentary letter from Inge Lehmann. But instead of debate, discussion, and experimental and/or theoretical verification/ refutation, I received silence from the geophysics community, not only on that discovery, but on a host of discoveries that followed as a consequence.[15] Real scientists welcome new ideas and advances as they open the door to more new ideas and further advances. **Science-barbarians, on the other hand, ignore what they do not like, and by ignoring, deceive the scientific community, the general public, and the U.S. Government, which typically funds their questionable endeavors.**

In 1838, in an address before the Young Men's Lyceum of Springfield, Illinois, Abraham Lincoln stated: "*At what point, then, is the approach of danger to be expected? I answer if it ever reaches us, it must spring up amongst us. It cannot come from abroad. If destruction be our lot, we must ourselves be its author and finisher*." Later, U.S. President Abraham Lincoln unknowingly helped to sow the seeds for America's self--destruction when in 1863 he signed into law the Act of Incorporation of the National Academy of Sciences, which states in part: "*The National Academy of Sciences shall… whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art.*"

Has the National Academy of Sciences ever advised the U.S. Government of the flaws in the operating procedures of science-funding agencies, such as I have disclosed,[1,2] which are corrupting and trivializing American science? Has it ever revealed the existence of organized science-suppression under the guise of secret 'peer review' among the so-called professional societies, including within the National Academy of Sciences, the documentation of which I have provided to the president of NAS, and the consequences of which will cost American taxpayers countless millions of wasted tax dollars? I doubt it. Despite ever increasing budgets, American science and education continues to decline toward third-world status as it has for decades. In personal, medical, legal, and business matters, it is common practice to hire an advisor. We all do that. If the advice proffered proves to be faulty, we fire the advisor and hire another. In my opinion, the United States Congress should fire the U.S. National Academy of Sciences, and find other sources of scientific and educational advice.

Suppressing and ignoring advances in science can have serious, real-world consequences. The Earth is constantly bombarded by the solar wind, a fully ionized and electrically conducting plasma, heated to about

1,000,000 °C. Fortunately, Earth's self-generated magnetic field deflects the brunt of the solar wind safely around and past our planet, protecting humanity from the Sun's relentless onslaught.
But reversal or demise of the geomagnetic field will doubtlessly be catastrophic, a calamity of unparalleled magnitude for our technologically-dependent civilization.

When the geomagnetic field collapses, vast segments of the population will be without electricity. Electrical power grids will act like uncontrolled generators as the charged particle flux of the rampaging solar wind sweeps past, inducing into their lines suicidal bursts of electrical current that short circuit and destroy essential elements of the power grid. Powerful, equipment-wrecking electrical currents will likewise be induced in gas and oil pipelines, causing explosions and fires. Electrical charges will build up on surfaces every where and reach staggeringly high potentials at edges and sharp points, posing risks of electrocution and igniting fires. Satellites will no longer function, their electronics fried by the plasma onslaught; there will be widespread failure of both communication and navigation systems. And, even more seriously, the long-term, unknown, but certainly adverse, impact on health will be severe.

Until recently, reversals of the geomagnetic field or its complete demise were thought to be events in the far distant future and to occur over a long period of time. But that may have changed dramatically.

Notice that as you heat a pot of water on the stove top, before it starts to boil, the water begins to circulate from bottom to top and from top to bottom. This is called convection and it can be better observed by adding a few tea leaves, celery seeds, or the like, which are carried along by the circulation of water. It occurs because heat at the bottom causes the water to expand a bit, becoming lighter, less dense, than the cooler water at the top. This process of convection is an unstable, top heavy arrangement which attempts to regain stability by fluid motions.

In 1939, Walter Elsasser proposed that the geomagnetic field is produced by convection motions in the Earth's fluid core that are twisted by the planet's rotation to form a dynamo. For seventy years, the geophysics community has assumed that convection 'must' exist in the core. Untold millions of dollars have been spent on modeling convection and its applications in the Earth's fluid core.

On January 27, 2009, I submitted a brief but important scientific communication to *Physical Review Letters* which demonstrated that convection is *physically impossible* in the Earth's fluid core because: *(1*) The core is too bottom-heavy due to compression by the weight above; *(2)* The core-bottom cannot remain hotter than the top, as required for convection, because the core is wrapped in an insulating blanket; and, *(3)* The 'Rayleigh Number' has been wrongly applied to justify core-convection. I suggested instead that the geomagnetic field is produced by Elsasser's mechanism operating in the nuclear georeactor subshell. From bottom to top in the review process at *Physical Review Letters* and at the journal's sponsor, the American Physical Society, there were no scientifically valid, substantive criticisms, only pejorative remarks and misrepresentations, including those by one or more members of the National Academy of Sciences. Of course, the paper was rejected by *Physical Review Letters* and its preprint was 'buried' by *arXiv.org* in General Physics,[16] which effectively hid it from view of U.S. Government science funding officials, almost guaranteeing that fluid core modeling activities would continue wasting tax payer funds on fruitless, physically impossible endeavors. But there is a far, far more serious implication stemming from the un-warranted rejection and 'burial' of this manuscript.

Earth's fluid core comprises about 30% of the mass of the planet; the nuclear georeactor is only one ten--millionth as massive, meaning that disrupted convection in the georeactor could lead to very rapid changes, including rapid reversals of the geomagnetic field. Think of it this way: the direction and speed of a child's tiny, self-moving toy train can be changed much more rapidly with far less force than that of the longest and heaviest, fully loaded, full-size freight train. From ancient lava flows, scientists have recently confirmed evidence of episodes of rapid geomagnetic field change – six degrees per day during one reversal and another of one degree per week – were reported.[17, 18] **The relatively small mass of the georeactor is consistent with the possibility of a magnetic reversal occurring on a time scale as short as one month or several years.** The recently observed more-rapid-than-usual movement of the North magnetic pole toward Siberia is thought by some to suggest that a reversal is imminent, although there is great uncertainty.

Because of the global catastrophic significance, suppressing science related to the possibility of very rapid geomagnetic field changes, in my view, is tantamount to a betrayal of trust and an act of treason against humanity.

For the good of all, now is the time to rid science of the charlatans and the science-barbarians, and to create an environment where science can flourish in truth and where scientists can work freely without fear of retribution or denouncement for challenging extant ideas or for failing to adopt the ‘politically correct’ consensus-approved storyline. I have described four major, science-crippling flaws, instigated by the U.S. National Science Foundation a half-century ago, that are still in effect today at NSF, and at other U.S. Government science funding agencies, and have suggested practical ways to correct them.[1] Implementation should not be too difficult; it just requires courage and integrity.

ABOUT THE AUTHOR

J. Marvin Herndon is well trained: B.A. in physics (UCSD), Ph.D. in nuclear chemistry (Texas A&M), and post-doctoral apprenticeship in geochemistry and cosmochemistry under Hans E. Suess and Harold C. Urey. Dubbed a “maverick geophysicist” (by The Washington Post), this interdisciplinary scientist is responsible for identifying the composition of Earth’s inner core as nickel-silicide and for demonstrating the feasibility of a natural nuclear reactor at Earth’s center as the energy source and production mechanism for the geomagnetic field. His professional life has been one of discovering long-standing fundamental scientific mistake; now he reveals managerial mistakes that have been crippling and corrupting American science and education for decades.

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Further readings

Ogrin, S., 2010(11). “Ghost in the Machine.” *The Dot Connector Magazine*, p. 38-40.
Perelman, C.C., 2010(11). “The Trouble with Physicists.” *The Dot Connector Magazine*, p. 41-43.

(**Editor’s note:** This article was recaptured from *The Dot Connector Magazine*, v. 2, no. 14, p. 25-32, 2011 with permission of the publisher and the author. http://www.thedotconnector.org/mag/)

PUBLICATIONS

Current status of seismo-electromagnetic for short-term earthquake prediction

Hayakawa, M. and Hobara, Y., *Geomatics, Natural Hazards and Risk*, v. 1, no. 2, p. 115-155.
DOI: 10.1080/19475705.2010.486933. hayakawa@whistler.ee.uec.ac.jp; http://www.tandf.co.uk/journals.

Excerpt from abstract: Short-term (time scale of hours, days and weeks) earthquake (EQ) prediction is of essential importance to mitigate EQ disasters. Short-term EQ prediction has so far been based on seismic measurements (i.e. mechanical observation of crustal movements), but it was concluded in Japan about 10 years ago that EQ prediction is impossible by means of the mechanical method. Hence, there has been as increased interest and a lot of progress in non-seismic measurement during the last decade. A new approach was developed where electromagnetic measurements provide microscopic information on the lithosphere. …this paper reviews the current status of a new science field, 'seismo-electromagnetics'. We make a general review of different phenomena taking place in the lithosphere, atmosphere and the ionosphere, but we pay more attention to the subjects of our preference including lithospheric ultra-low frequency (ULF) electromagnetic emissions, and seismo-ionospheric perturbations.

Some of the interesting passages in the paper are as follows:
"...in 1998 a report was published by the Geodesy Council of the former Ministry of Education of Japan that EQ prediction is impossible. Since then, the myth of impossibility of EQ prediction has prevailed among seismologists and then in the mass media. However, the report should be modified as follows, 'EQ prediction by means of conventional seismic measurement [*based on plate subduction model* – added by the Editor] is impossible.' **Such a general conclusion by seismologists might be related to their haughty attitude that because seismologists cannot predict EQs, nobody else can do it.** (p. 116) [emphasis by the Editor]"

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Strong earthquakes can be predicted: a multidisciplinary method for strong earthquake prediction

Li, J.Z., Bai, Z.Q., Chen, W.S., Xia, Y.Q., Lie, Y.R. and Ren, Z.Q., 2003. *Natural Hazards and Earth System Science* (European Geoscience Union), v. 3, p. 703-712.

Abstract (excerpt): The imminent prediction on a group of strong earthquakes that occurred in Xinjiang, China in April 1997 is introduced in detail. The prediction was made on the basis of comprehensive analyses on the result obtained by multiple innovative methods including measurements of crustal stress, observation of infrasonic wave in an ultra-low frequency range, and recording of abnormal behavior of certain animals. The statistics shows that above 40% of 20 total predictions jointly presented by J.Z. Li, Z.Q. Ren and others since 1995 can be regarded as effective. With the above methods, precursors of almost every strong earthquake around the world that occurred in recent years were recorded in our laboratory.

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David Pratt's website

You can find many interesting articles by David Pratt, one of our editorial members, on his home page, www.davidpratt.info. Some of the latest articles are:

The energy future: http://davidpratt.info/energy.htm (June 2011)
Sunken continents versus continental drift. http://davidpratt.info/sunken.htm (March 2011)
Climategate and the corruption of climate science: http://davidpratt.info/climategate.htm (March 2010)

Partial radiogenic heat model for Earth revealed by geoneutrino measurements

The KamLAND Collaboration

Nature Geoscience, v. 4, p. 647–651, published online on 17 July, 2011. DOI: doi:10.1038/ngeo1205
http://www.nature.com/ngeo/journal/v4/n9/full/ngeo1205.html#

Abstract: The Earth has cooled since its formation, yet the decay of radiogenic isotopes, and in particular uranium, thorium and potassium, in the planet's interior provides a continuing heat source. The current total heat flux from the Earth to space is 44.2±1.0 TW, but the relative contributions from residual primordial heat and radiogenic decay remain uncertain. However, radiogenic decay can be estimated from the flux of geoneutrinos, electrically neutral particles that are emitted during radioactive decay and can pass through the Earth virtually unaffected. Here we combine precise measurements of the geoneutrino flux from the Kamioka Liquid-Scintillator Antineutrino Detector, Japan, with existing measurements from the Borexino detector, Italy. We find that decay of uranium-238 and thorium-232 together contribute $20.0^{+8.8}_{-8.6}$ TW to Earth's heat flux. The neutrinos emitted from the decay of potassium-40 are below the limits of detection in our experiments, but are known to contribute 4 TW. Taken together, our observations indicate that heat from radioactive decay contributes about half of Earth's total heat flux. We therefore conclude that Earth's primordial heat supply has not yet been exhausted.

(Relevant paper by H.N. Pollack, S.J. Hurter and J.R. Johnson, Heat flow from the Earth's interior: analysis of the global data set. *Review of Geophysics*, v. 31, p. 267-280, 1993)

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First Cretaceous mammal from India

G.V.R. Prasad and A. Sahni, 1988. *Nature*, v. 332, p. 638-640; doi:10.1038/332638a0

The record of Cretaceous mammals in particular and Mesozoic mammals in general is biased in favour of the Laurasian landmass. There are relatively few reports of these mammals from the southern continents representing Gondwanaland, and most of these are confined to northwestern South America. Here we report the discovery of a new eutherian mammal from the uppermost Maastrichtian sediments intercalated in a volcanic sequence in Naskal, Andhra Pradesh, India. This first record of a south-Asian Cretaceous mammal indicates a wide distribution of these creatures and suggests that **the Indian plate was not isolated from northern continents despite the geological evidence.** Our finds may also contribute to the understanding of the origin and evolution of therian mammals from mammal-like reptile (therapsids) which are well known from the southern continents.

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Should the laws of gravitation be reconsidered?

The Scientific Legacy of Maurice Allais

Edited by Hector A. MUNERA
Published by Apeiron, Montreal (in English)
Available from www.amazon.com

Should the laws of gravitation be reconsidered?, asked the title of Maurice Allais' 1954 iconoclastic paper. Any true scientist should have simply answered, "Yes, all scientific theories should be constantly reconsidered, if for no other reason than to make their believers remember why they believed in them in the first place." But by 1954 there was one and only one accepted theory of gravitation and that was Einstein's general theory of relativity (GR). Unlike most scientific theories, GR could never be considered an intermediate theory, a stepping stone to a more complete understanding of the universe. It interpreted the gravitational force differently than any force up until then. It required the speed of light to be exactly constant in all inertial reference frames and space to be perfectly isotropic. Even the slightest departure from these assumptions meant that the whole theory "would collapse like a house of cards." Many careers in physics, astronomy and geology were invested in this theory and questioning it ended many other careers. Allais' asking this question in 1954 was an act of intellectual and professional courage.

I first became aware of Allais' 1954 paper in 1985. Since I once studied gravity at the graduate level, I was amazed that no one ever mentioned it to me before. I soon started corresponding with the late John Bagby who collected and translated Allais's papers on gravity. In 1988 I had the good fortune of working for a non-profit when one of its editorial advisers named "Maurice Allais" won the Nobel Prize in Economics. Of course I had to ask, "By any chance is he related to the physicist, Maurice Allais?" I then received a quick education as to the breadth of Allais's accomplishments.

One of Allais' qualities that I found most impressive was his willingness to correspond with amateur researchers and his willingness to help those pursuing controversial topics. Here was a Nobel Laureate willing to help the nobody-pursuing non-tidal correlations between earthquakes and lunar-solar position, when mediocre researchers at mediocre institutions would not even return phone calls requesting data.

In 1999 I was sharing an office with two other physicists when NASA was planning to "test" Allais' eclipse effect. We discussed the implications of this experiment. I remember the morning when one of them greeted me by announcing that the result was "null." His face and tone expressed a sense of relief and satisfaction.

Fortunately for science, there are still those willing to look at all data and explore all possibilities; and I am thankful that Hector Munera asked me to join them in assembling this book. And I am also thankful that Roy Keys is willing to publish it. This book was necessary. It contains benchmark papers which were rejected when written and new papers that I am sure will become benchmarks.

As I read through the contributions, I had one surprise after another which gave rise to one idea after another. (How I wish I could have read this book when I was twenty!) One cannot read this book without concluding that something not predicted by GR occurs during an eclipse and most likely during the various orbital cycles. For the first time we have independent researchers over a hundred kilometres apart and using different instruments finding gravitational anomalies with similar time signatures. It is just too much to be coincidence. The papers describing a null result should not be thought of as affirming GR, but as part of a scientific effort to better describe the anomalies.

These papers allege periods in spatial anisotropy and anomalous torsions that correspond not only to lunar and solar periods, but also to sidereal periods – the time it takes to rotate in absolute space. What I find amazing is that for decades other researchers have been claiming a sidereal period in earthquakes only to be categorically dismissed. There is also another earthquake anomaly that pertains here. Not in general, but in a few specific areas, there is a preponderance of earthquakes near eclipses. Any correlation is generally discredited because often the earthquakes precede the eclipse by a half hour or so. Can you imagine my astonishment when I read in the following papers that notable gravity anomalies occur in that time frame?

Arguments about gravitational anomalies that are measured in parts per million are often thought of as the sole interests of cosmologists, theoretical physicists, philosophers, and science fiction buffs. But as this book goes to press the world is still discovering the magnitude of the Fukushima disaster. It is totally appropriate to attribute the lack of progress in earthquake prediction on rigid adherence to a long-discredited tectonic model propped up by a religious belief in static gravity as required by general relativity.

The title of this book is a repetition of the question originally asked by the title of Allais' 1954 paper, "Should the laws of gravitation be reconsidered?" The collected papers not only answer a resounding

"Yes," but go a long way in suggesting how the laws should be rewritten and what future theories of gravity may look like.

From the preface by Martin KOKUS
martinkokus@yahoo.com

NEWS

34th INTERNATIONAL GEOLOGICAL CONGRESS BRISBANE, AUSTRALIA. 5 – 10 AUGUST, 2012

www.34igc.org

Important dates to remember:

1 November 2011	GeoHost support scheme applications close. Apply here
December 2011	Fourth Circular released
17 February 2012	Abstract submissions close. Submit abstracts here
31 March 2012	Field trip bookings close
30 April 2012	Early Bird registrations close (Standard registration rate commences) Presenters registration deadline.
5 June 2012	Accommodation reservations to be made by this date
1 July 2012	Standard Congress registrations close (Late registration rate commences)
July 2012	Fifth Circular - Final Program

NCGT session: Theme 37, Alternative Concepts, *Pursuit of a new geodynamic paradigm*
Conveners:
Ismail Bhat, bhatmi@hotmail.com
Karsten Storetvedt: Karsten@gfi.uib.no
Dong Choi: raax@ozemail.com.au

Major topics:
1. Critical tests of plate tectonics paradigm: factual evidence and its implications for global geodynamics.
2. Global tectonics, natural hazards, their prediction and planetary interaction
   1) Earthquakes, volcanic eruptions, their prediction and planetary interaction
   2) Global climate from the perspective of new global geodynamics
3. Dynamics of the Earth and new global geodynamic paradigms

Following keynote speakers have been confirmed (one or two may be added):
Boris Vasiliyev – Ancient and continental crust from the world oceans
Takano Yano – Ancient and continental crust from the world oceans
Karsten Storetvedt – Magnetic anomalies and related aspects
Ismail Bhat – Global climate and new global geodynamics
Dong Choi – Earthquake prediction from a new tectonic perspective

Currently over 35 invited presentations have been confirmed or under negotiation, some pending on funding. Both oral and poster sessions are planned. Those who wish to present papers at the NCGT session, please contact one of the session conveners.

Young scientists (35 years or younger) from low income countries who wish to attend the IGC and present papers at the NCGT session are entitled to apply for **GeoHost Support Program**. **The submission deadline is 1 November, 2011**. Visit www.34igc.org for more information.

APPEAL FOR FUND RAISING TO SUPPORT INVITED SPEAKERS WHO HAVE FINANCIAL DIFFICULTIES: There are five to six scientists in countries with a disadvantageous currency exchange rate who wish to present papers at our session but have no or only limited organizational support. **They are seeking financial support from us to defray some travel, registration and other expenses. We invite your generous financial contribution earmarked to the "NCGT special fund for IGC" to enable them to attend the congress.** Please send your donation to the NCGT – bank account details below.

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FINANCIAL SUPPORT

Following suggestions from many readers, NCGT Newsletter has become an open journal. Now anyone can access all issues without log in. This will increase the number of readers dramatically. This means we have to rely on good-will, voluntary donations from readers as well as commercial advertisements to defray the journal's running costs. We welcome your generous financial contributions. Hard copy subscription fee; US$140/year (or equivalent euros) plus postage. Advertisement fee structure: ***Premium positions.*** Page 3 (after the Editorial), full page – U$200/issue, U$720/year. Back cover, full page – U$100/issue, U$360/year (or equivalent euros). Half page – 80% of the full-page price; ***Other positions***. 10% discount from the back-cover price. For more information, please contact editor@ncgt.org.

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Name of bank: Commonwealth Bank (Swift Code: CTBAAU2S), Belconnen Mall ACT Branch (BSB 06 2913).
Account no. 06 2913 10524718.
Name of account holder: New Concepts in Global Tectonics.

ABOUT THE NCGT NEWSLETTER

This newsletter was initiated on the basis of discussion at the symposium "Alternative Theories to Plate Tectonics" held at the 30th International Geological Congress in Beijing in August 1996. The name is taken from an earlier symposium held in association with 28th International Geological Congress in Washington, D. C. in 1989.

Aims include:

1. Forming an organizational focus for creative ideas not fitting readily within the scope of Plate Tectonics.
2. Forming the basis for the reproduction and publication of such work, especially where there has been censorship or discrimination.
3. Forum for discussion of such ideas and work which has been inhibited in existing channels. This should cover a very wide scope from such aspects as the effect of the rotation of the earth and planetary and galactic effects, major theories of development of the Earth, lineaments, interpretation of earthquake data, major times of tectonic and biological change, and so on.
4. Organization of symposia, meetings and conferences.
5. Tabulation and support in case of censorship, discrimination or victimization.

Climate-Stat

http://www.climatestat.com

Geophysical Forecasting and Modeling with G-MagTeleDyn

Climate Stat develops gravity/magnetic teleconnection dynamics climate models to account for short-term (hourly to monthly and seasonal) and long-term (decadal and inter-decadal) geophysical variations affecting electromagnetic, gravitational, and thermal coupling parameters to atmospheric forcing.

Weather Information Technology:

Preliminary research suggests a moderate likelihood that significant improvements to hurricane and weather prediction models can be made. Geophysical modeling outputs are tested in historical atmospheric circulation models to improve conventional models.

Products:

~Geoids & Magnetic Field Modeling
~Relational Database Mining for Climate Signals
~Geophysical Inputs for Forecasting
~Visualization Packages
To improve accuracy in global weather forecasting, commodity trading, and insurance actuary support.

Potential Customers are: Internet Information Companies, Weather Forecasters, Insurance Companies (Actuaries), Commodity Traders, Military, and Maritime Shipping Industry.

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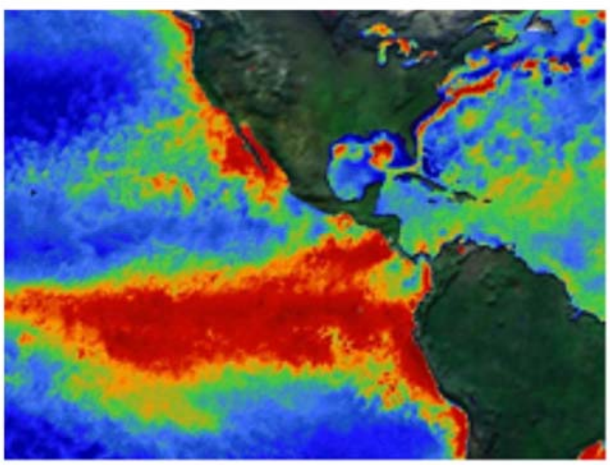

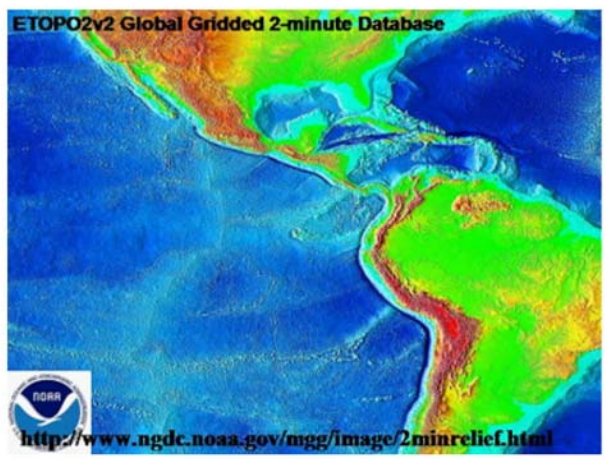

Left figure: Full Blown El Nino Feb. 1998 Sea Surface Temperature Signal.
Right figure: The Y structure in the Sea Surface Temperature Anomaly above as reflected in the sea floor ridge geomorphology below.

Bruce Leybourne - CEO / Geophysicist
leybourneb@hotmail.com