



## **EGU General Assembly 2014, held 27 April - 02 May, 2014 in Vienna, Austria**

**Session : [PS2.6 - Volcanism, tectonics, impacts and other geological processes across the Solar System](#)**

Convener: Thomas Platz

Co-Conveners: Alexander Deutsch, Harald Hiesinger, Fred Jourdan, Matteo Massironi, Pascal Allemand, Stephanie C. Werner, Paul Byrne

Geological processes such as volcanism, tectonics, and impacts are fundamental to the formation and evolution of the planets, moons, asteroids and comets of our Solar System. These processes are the primary agents responsible for the shaping of planetary surfaces, each of them in different ways and at different rates. For example, asteroids and comets have played a critical role during planetary evolution, by delivering the primary constituents of planetary bodies and by promoting resurfacing via impacts. Volcanic and tectonic processes are efficient mechanisms to reshape planetary surfaces and provide valuable information about planetary interiors and evolution. The study of geological processes in the Solar System is at the crossroad of many scientific disciplines using either in-situ sampling and analysis, remotely sensed data, or experimental and numerical modelling.

This session aims to compile all facets of volcanism, tectonism, impact cratering, and their associated interactions with other geological processes observed in our Solar System. By providing a forum for a broad range of discussions, these observations and interpretations will be investigated and (re)viewed in the light of our current understanding of related processes on Earth. Comparative studies on volcanic/tectonic systems, impact structures, and other processes on Earth using multi-instrumental, remotely sensed, experimental, computational, or field data are particularly welcome.

## Significant statistically relationship between the great volcanic eruptions and the count of sunspots from 1610 to the present

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### Abstract

The assertion that solar activity may play a significant role in the trigger of large volcanic eruptions is, and has been discussed by many geophysicists. Numerous scientific papers have established a possible correlation between these events and the electromagnetic coupling between the Earth and the Sun, but none of them has been able to highlight a possible statistically significant relationship between large volcanic eruptions and any of the series, such as geomagnetic activity, solar wind, sunspots number.

*[Abdurakhmanov,Firstov,Shirokov,1976][Casati;Straser,2013][Casey,2010][Charvátová,2010][Duma;Vilardo,1998][Jaggar,1931][Jensen,1902,1904][Lyons,1899][Madonia;Gurrieri;Inguaggiato;Giugliano;Romano;Spadaro;Zuccarell o,2005][Mazzarella;Palumbo,1989][O'Relly,1899][Stothers,1989][Střeštitk,2003][Sytinsky,1998][Kolvankar,2008]*

In our research, we compare the 148 volcanic eruptions with index VEI4, the major 37 historical volcanic eruptions equal to or greater than index VEI5, recorded from 1610 to 2012, with its sunspots number. Staring, as the threshold value, a monthly sunspot number of 46 (recorded during the great eruption of Krakatoa VEI6 historical index, August 1883), we note some possible relationships and conduct a statistical test.

- Of the historical 31 large volcanic eruptions with index VEI5+, recorded between 1610 and 1955, 29 of these were recorded when the SSN<46. The remaining 2 eruptions were not recorded when the SSN<46, but rather during solar maxima of the solar cycle of the year 1739 and in the solar cycle No. 14 (Shikotsu eruption of 1739 and Ksudach 1907) (chart 1).
- Of the historical 8 large volcanic eruptions with index VEI6+, recorded from 1610 to the present, 7 of these were recorded with SSN<46 and more specifically, within the three large solar minima known : Maunder (1645-1710), Dalton (1790-1830) and during the solar minimums occurred between 1880 and 1920. As the only exception, we note the eruption of Pinatubo of June 1991, recorded in the solar maximum of cycle 22 (chart 2).
- Of the historical 6 major volcanic eruptions with index VEI5+, recorded after 1955, 5 of these were not recorded during periods of low solar activity, but rather during solar maxima, of the cycles 19,21 and 22.

The significant tests, conducted with the chi-square  $\chi^2 = 7,782$ , detect a p-value equal to 0,005. Applying a correction of Yates, p-value assume the value of 0,009.

We affirm therefore that the occurrence of a major volcanic eruption, greater or equal to VEI4 index, during the weak solar cycles, is statistically significant and justifies the hypothesis of large volcanic eruptions in the next decade, with reference not only to the weakness of the current solar cycle SC24, but the probable entrance, in a long and deep solar minimum, during the transition to the next solar cycle SC25. Assumption formulated by many solar physicists.

*[Ahluwalia,2013][Goelzer;Smith;Schwadron;McCracken,2013][Livingston;Penn;Svalgaard,2012][Steinhilber;Beer,2013]*

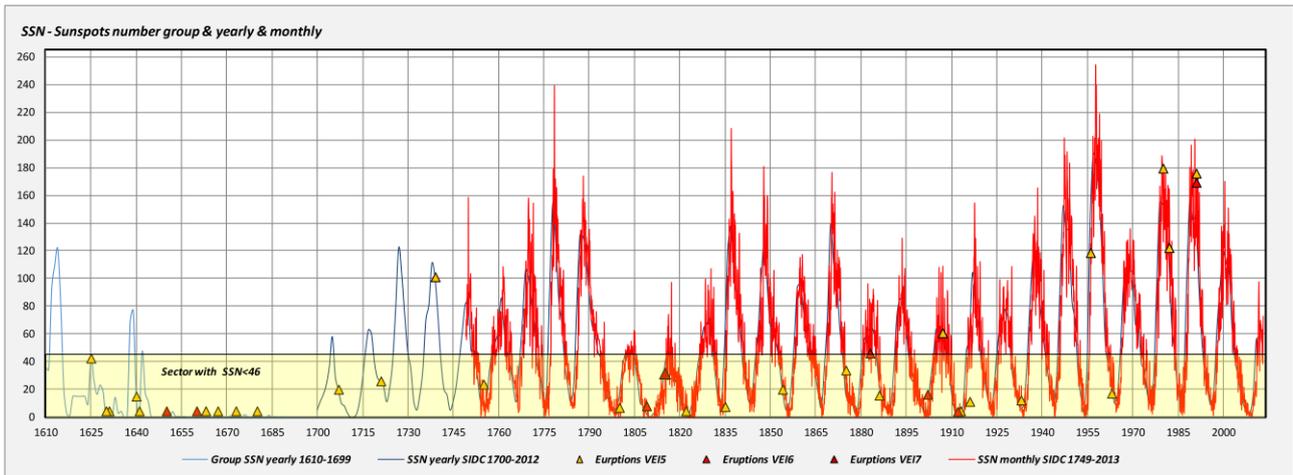
<b>Volcano</b>	<b>Date eruption</b>	<b>Index VEI</b>	<b>Relative sunspots number (*)</b>
Hudson Cerro	12/08/1991	5+	176,3
Pinatubu	15/06/1991	6	169,7
El chichon	03/04/1982	5	122
St.helen	18/05/1980	5	179,9
Agung	17/03/1963	5	17,1
Benzymianny	30/03/1956	5	118,4
Kharimkotan	08/01/1933	5	12,3
Cerro azul	10/04/1932	5+	11,2
Colima	20/01/1913	5	2,3
Novarupta	06/06/1912	6	4,1
Ksudach	28/03/1907	5	60,7
Santa maria	24/10/1902	6	16,3
Mount tarawera	10/06/1886	5	15,7
Krakatoa	27/08/1883	6	46
Askja	29/03/1875	5	33,8
Shiveluch	18/02/1854	5	20
Cosiguina	20/01/1835	5	7,5
Galunggung	08/10/1822	5	0,4
Tambora	10/04/1815	7	31,6
Source Unknown (*1)	1809	6	2,5
St. Helens	15/01/1800	5	6,9
Katla	17/10/1755	5	23,7
Shikotsu	19/08/1739	5	101
Katla	11/05/1721	5	26
Fuji	16/12/1707	5	20
Tongkoko	1680	5	0,8
Gamkonora	20/05/1673	5	0
Shikotsu	23/09/1667	5	0
Usu	16/08/1663	5	0
Long island	1660±20years	6	0
Shiveluch	1650±10years	5	0
Kolumbo Santorini	1650	6	0
Parker	04/01/1641	5	0
Komaga-take	31/07/1640	5	15
Vesuvius	16/12/1631	5	4,4
Furnas	03/09/1630	5	0
Katla	02/09/1625	5	42,4

**Table 1 - Catalogue volcanic eruptions equal to or greater than VEI5 index occurred from 1610 to the present and relative sunspots number**

The list of the major historical eruptions are extracted from the Smithsonian Institute (Global Volcanism Program). The sunspots number is extracted from the Belgium Solar Influences Data Analysis Center (SIDC).

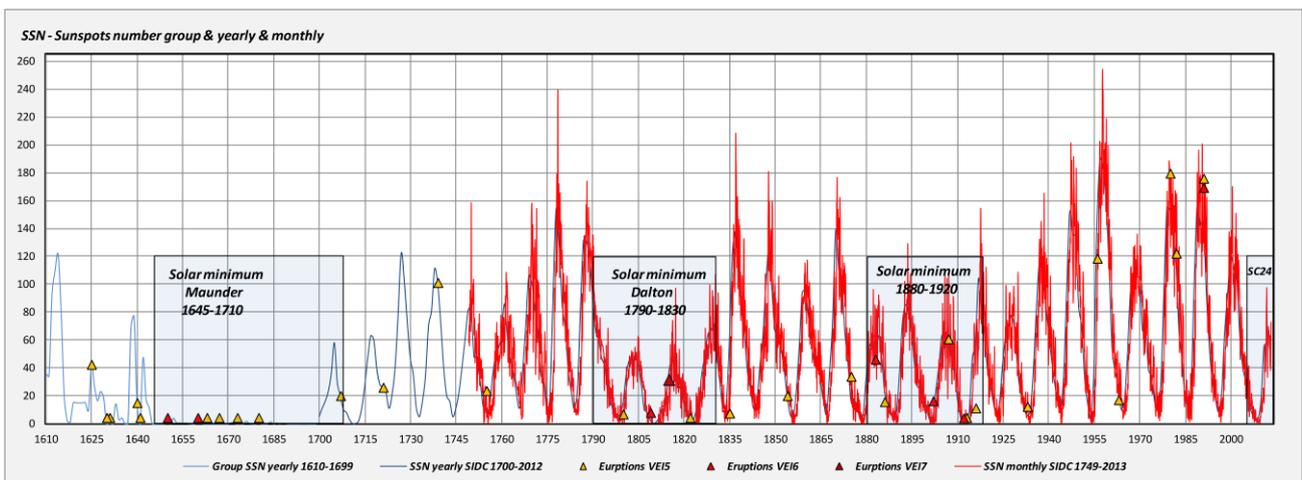
(\***) Relative sunspots number** Data : Group SSN yearly from 1610 to 1699; SSN yearly "SIDC" from 1700 to 1748; SSN monthly "SIDC" from 1749 to present.

(\***1**) Jihong Cole-Dai, David Ferris, Alyson Lanciki, Joël Savarino, Mélanie Baroni, Mark H. Thiemens **Cold decade (AD 1810–1819) caused by Tambora (1815) and another (1809) stratospheric volcanic eruption** *Geophysical Research Letters* Volume 36, Issue 22, November 2009 doi: 10.1029/2009GL040882



**Chart 1 - Volcanic eruptions occurred with SSN < 46**

The yellow area represent the period from 1610 to the present and includes 30 of the 37 volcanic eruptions equal to or greater than VEI5 index.



**Chart 2 - Deep solar minimum and large volcanic eruptions equal to or greater index VEI6**

Seven of the eight major volcanic eruptions equal to or greater than VEI6 index have occurred during three well-known historical periods: Maunder, Dalton and the period of solar minimum occurred from 1880 to 1920. All these periods are characterized by a very low solar electromagnetic activity.

## Appendix

It is possible to observe a relationship between large earthquakes with a magnitude of M8.3+ and the well-known two periods included in the eleven-year cycle of the solar magnetic activity: solar minimum and solar maximum (Chart 3). However, this analysis did not show any statistically significant relationship.

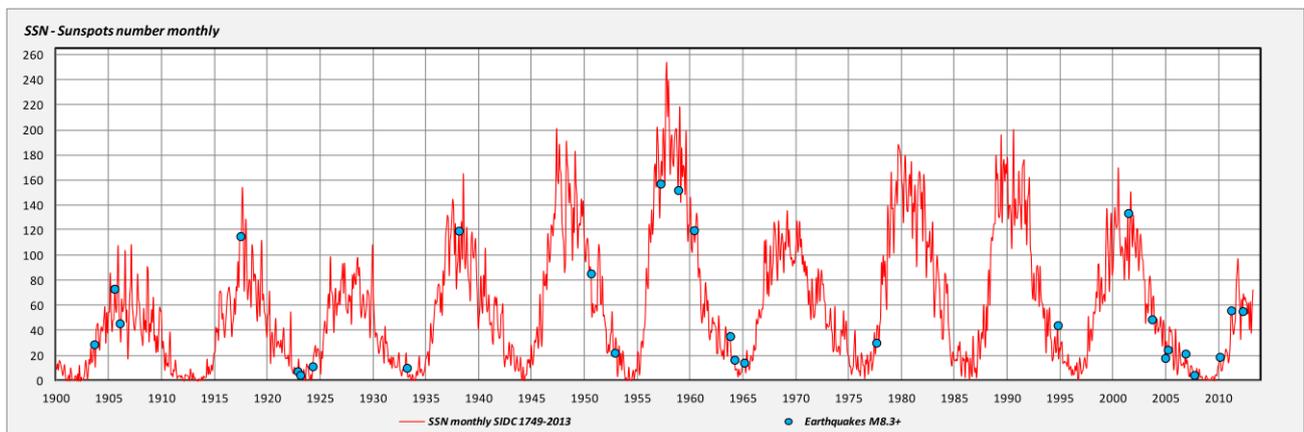
The list of 29 events of magnitude M8.3 + occurred since 1900 is extracted by the U.S. Geological Survey.

[http://earthquake.usgs.gov/earthquakes/eqarchives/year/mag8/magnitude8\\_1900\\_date.php](http://earthquake.usgs.gov/earthquakes/eqarchives/year/mag8/magnitude8_1900_date.php)

Of the 29 earthquakes of magnitude M8.3 + :

- 17 have occurred when the SSN (monthly) < 46;
- 9 have occurred in the years of solar maximum, cycles 14, 15, 17, 23 and 24;
- 3 have not occurred during the years of solar minimum or maximum.

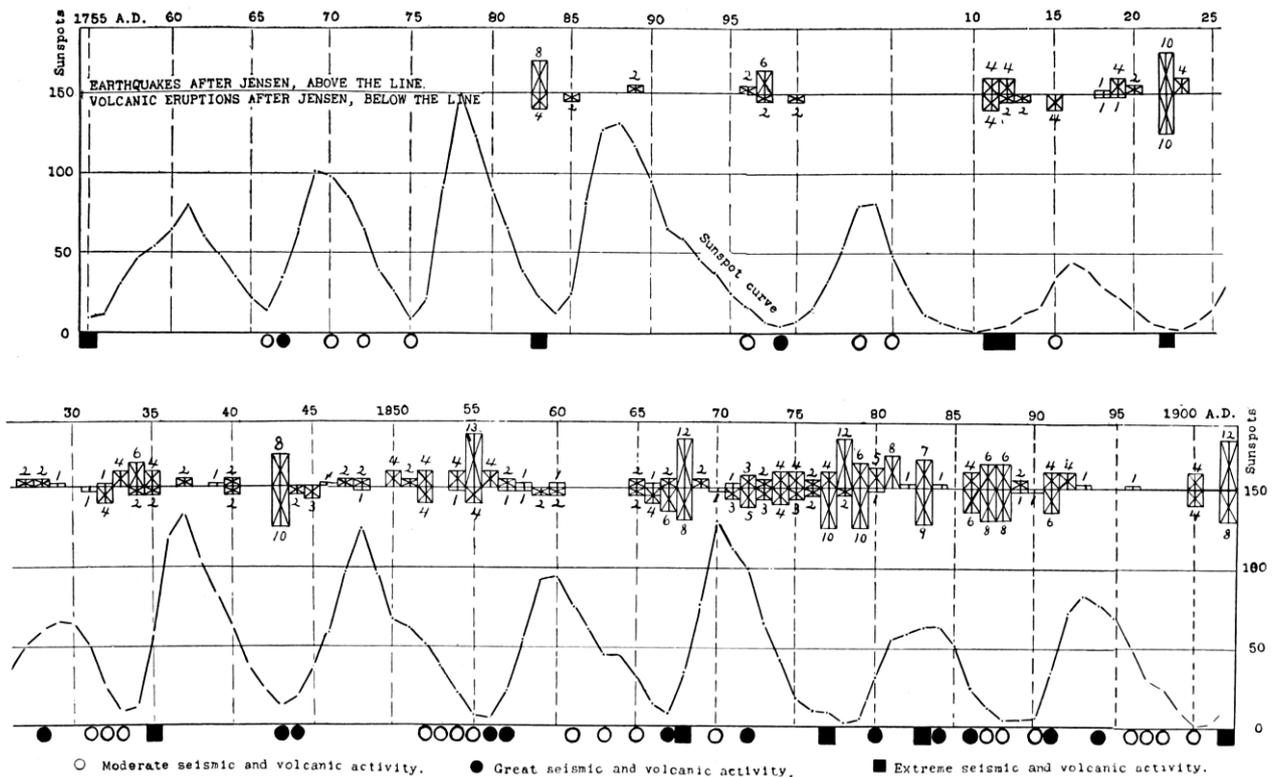
### Chart 3 – Seismic events of magnitude M8.3 + and relative monthly sunspots number



## Memories

In the "Popular Science Monthly Volume 72 - June 1908, Dr. Ellsworth Huntington published this chart and say:

*"... If the activities of the earth and of the sun are related to one another in any such manner as is suggested above, the study of the one will add vastly to our knowledge of the other. An examination of solar changes, on the one hand, may enable us to foretell something of what is about to occur upon the earth. A careful reading of the geological history of the earth, on the other hand, may disclose the history of the sun for millions of years past, and may shed light upon the fascinating problem of the thermal history and ultimate destiny of the body which, as knowledge increases, appears more and more to be the arbiter of terrestrial life."*



**The relation of sunspots to earthquakes and volcanoes 1755AD - 1900AD**

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