



















"Our own view is that the same natural substance causes wind on the earth's surface, earthquakes beneath it, and thunder in the clouds; for all these have the same substance, the dry exhalation. If it flows in one way it is wind, in another it causes earthquakes..."







one model of the Earth's interior, 1685

## More speculation from famous people: fires, explosions, etc.

According to **RENE DESCARTES** (<u>1596 - 1650</u>) the fire-fluid and sunlike core of the earth is surounded by a spherical shell of metals. This solid shell is enclosed by another one consisting of water and another one consisting of air. Beyond this last shell there is the freely floating earth crust which, however, is broken in several pieces. Thereby mountains and seas have been formed. As for earthquakes as well as eruptions of volcanoes they are caused by an accidental spark which is inflamed by sulphuric vapour in crevices and caves of the earth's crust. Thus the walls of the caves are shaken:







**BENJAMIN FRANKLIN**: the core of the earth consists of an air sphere highly compressed (and hence dense). In his opinion the crust of the earth is swimming on this air sphere, with the atmosphere being above the crust. Due to the rotation of the earth around its axis, the inner fluid changes its shape so that the crust could burst. In addition wave-like movements (undulations) originate below the crust, due to the expansion of vapours putting pressure on the inner fluid. These undulations are distributed over wide areas and may cause tremors over large regions.

CHARLES DARWIN: earthquakes are the consequences of a phenomenon analogous to volcanic eruptions. A layer of liquid magma is postulated to lie beneath the crust and an earthquake is a failed volcanic eruption.

"In a primary volcanic outburst, we know the cause to be the explosion of liquid and aeriform matter, first through solid strata, and afterwards through a nearly open passage; hence we are led to conclude, that the cause of the simple earthquake, with its secondary shocks, are explosions of a similar nature, which, however, do not open a passage, but rend successively portions of the superincumbent masses."

### Japan and China - earthquakes due to 'imbalances in the 5 Yin and Yang forces' (similar to the five Greek elements).



Namazu (in Japan) = myth or symbol more than a serious explanation

China and Japan - detailed catalogues of earthquakes going back hundreds to thousands of years

Seismology as a quantitative science started in Japan in the late 1800's



## Gravity is 'discovered' and then...

#### "It either happens due to a real vibration of the ground or not"

On 18 February 1756 between 8 and 8.30 Germany and the Netherlands were affected by an earthquake. Both in Göttingen, where TOBIAS MAYER was director of the observatory, and in Hannover, where JACOBI was writing his treatise on earthquakes in (response to the 1755 Lisbon earthquake), the earth shocks could be noticed. Both scientists reported the dizziness they felt during the earthquake.

Their theoretical explanation of these phenomena was totally different. While TOBIAS MAYER tried to explain this dizziness by a change of gravity with the ground of the earth not moving at all, JACOBI attributed them to real movements of the ground.

The purely speculative ideas of subterranean vapours, fires and flames as primary causes of the tremors at the surface of the earth finally gave MAYER the courage, against general opinion that the so-called "earthquakes" are in fact tremors or movements of the ground, to formulate his totally new hypothesis of a short-time local change in the direction of gravity, with the ground itself remaining unmoved and the objects on it moving around. According to this hypothesis the term "earthquake" was not really correct, like in astronomy the terms "sunset" and "sunrise":

This hypothesis did explain collapsing houses, strange movements of water masses that were far away, and the subjective feeling of dizziness that is similar to sea-sickness.

# Detailed surveys, seismograms, and photographs showed that the ground really does move...



The Great Earthquake
JAPAN, 1891.
äv
JOHN MILNE, F.R.S. PROFESSOR OF MINING AND GEOLOGY: IMPERIAL UNIVERSITY OF JAPAN,
W. K. BURTON, C.E. PROFESSOR OF SANTARY EXCINERING; INFERIAL UNIVERSITY OF JAPAN, PRATES W
K. OGAWA.
SECOND EDITION.
PUBLISHED BY LANE, CRAWFORD & CO., YOKOHAMA, JAPAN.
PROFESSION AND THE DOWN TRANSPORT

#### Part of a table from the Lawson Report (1906 California earthquake)

Station	Latitude After 1868			Latitude 1906-07	Longitude After 1868			Longitude 1906-07	Southward Component of Displacement	Eastward Component of Displacement	Direction of Displacement	Amount of Displacement		Relation to Fault			Degree of Certainty
Group 1.									Meters	Meters		Meters	Feet	Km.	Miles	Dir.	
Rocky Mound	37°	52'	57.253"	57.262"	122°	14'	30.507"	30.515"	- 0.28	- 0.20	145°	0.34	1.1	32	20	E	Doubtful.
Red Hill	37	33	04.730	04.738	122	05	40.982	40.975	- 0.25	+ 0.17	215	0.30	1.0	19	12	E	Doubtful.
Sierra Morena	37	24	38.266	38.305	122	18	28.006	28.054	- 1.20	- 1.18	136	1.68	5.5	4.3	2.7	w	Certain.
Mount Tamalpais	37	55	27.507	27.492	122	35	45.242	45.228	+ 0.46	+ 0.34	324	0.58	1.9	6.4	4.0	E	Certain.
Farallon Lighthouse	37	41	58.250	58.277	123	00	03.605	03.669	- 0.83	- 1.57	118	1.78	5.8	37	23	w	Certain.
Pt. Reyes Light-house	37	59	45.458	45.572	123	01	20.577	20.618	- 0.43	- 1.00	113	1.09	3.6	19	12	w	Doubtful.



The foregoing work set the stage for the late 1800s and early 1900s, when many fundamental advances in seismology would be made. In Japan, three English professors, John Milne, James Ewing, and Thomas Gray, working at the Imperial College of Tokyo, invented the first seismic instruments sensitive enough to be used in the scientific study of earthquakes