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Charles Darwin's earthquake reports

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As it is the 200th anniversary of Darwin's birth, 2009 has also been marked as 170 years since the publication of his book Journal of Researches. During the voyage Darwin landed at Valdivia and Concepcion, Chile, just before, during, and after a great earthquake, which demolished hundreds of buildings, killing and injuring many people. Land was waved, lifted, and cracked, volcanoes awoke and giant ocean waves attacked the coast. Darwin was the first geologist to observe and describe the effects of the great earthquake during and immediately after. These effects sometimes repeated during severe earthquakes; but great earthquakes, like Chile 1835, and giant earthquakes, like Chile 1960, are rare and remain completely unpredictable. This is one of the few areas of science, where experts remain largely in the dark.

Darwin suggested that the effects were a result of ' ... the rending of strata, at a point not very deep below the surface of the earth... ' and '... when the crust yields to the tension, caused by its gradual elevation, there is a jar at the moment of rupture, and a greater movement...'. Darwin formulated big ideas about the earth evolution and its dynamics. These ideas set the tone for the tectonic plate theory to come.

However, the plate tectonics does not completely explain why earthquakes occur within plates. Darwin emphasised that there are different kinds of earthquakes '...I confine the foregoing observations to the earthquakes on the coast of South America, or to similar ones, which seem generally to have been accompanied by elevation of the land. But, as we know that subsidence has gone on in other quarters of the world, fissures must there have been formed, and therefore earthquakes...' (we cite the Darwin's sentences following researchspace. auckland. ac. nz/handle/2292/4474). These thoughts agree with results of the last publications (see Nature 461, 870-872; 636-639 and 462, 42-43; 87-89). About 200 years ago Darwin gave oneself airs by the problems which began to discuss only during the last time.

Earthquakes often precede volcanic eruptions. According to Darwin, the earthquake-induced shock may be a common mechanism of the simultaneous eruptions of the volcanoes separated by long distances. In particular, Darwin wrote that '... the elevation of many hundred square miles of territory near Concepcion is part of the same phenomenon, with that splashing up, if I may so call it, of volcanic matter through the orifices in the Cordillera at the moment of the shock;... '.

According to Darwin the crust is a system where fractured zones, and zones of seismic and volcanic activities interact. Darwin formulated the task of considering together the processes studied now as seismology and volcanology. However the difficulties are such that the study of interactions between earthquakes and volcanoes began only recently and his works on this had relatively little impact on the development of geosciences.

In this report, we discuss how the latest data on seismic and volcanic events support the Darwin's observations and ideas about the 1835 Chilean earthquake. The material from researchspace. auckland. ac. nz/handle/2292/4474 is used. We show how modern mechanical tests from impact engineering and simple experiments with weakly-cohesive materials also support his observations and ideas.

On the other hand, we developed the mathematical theory of the earthquake-induced catastrophic wave phenomena. This theory allow to explain the most important aspects the Darwin's earthquake reports. This is achieved through the simplification of fundamental governing equations of considering problems to strongly-nonlinear wave equations. Solutions of these equations are constructed with the help of analytic and numerical techniques. The solutions can model different strongly-nonlinear wave phenomena which generate in a variety of physical context. A comparison with relevant experimental observations is also presented.