

ON THE POSSIBLE ORIGIN, PROPAGATION AND DETECTABILITY OF ELECTROMAGNETIC PRECURSORS OF EARTHQUAKES

SULLA POSSIBILE ORIGINE, PROPAGAZIONE E RIVELABILITÀ DEI PRECURSORI ELETTROMAGNETICI DEI TERREMOTI

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ABSTRACT

Some mechanisms on the origin of electromagnetic precursors, expected to be generated well before the occurrence of an earthquake, due to the process of rocks microfracture, are presented and discussed. The wide frequency spectrum of electromagnetic signals produced by the damped dipole oscillations caused by the microfracture process is described. The propagation of low frequency electromagnetic waves in the ELF and ULF range, belonging to such spectrum, is studied with reference to the electrical properties of rocks constituting the lithosphere. The characteristics and the possible propagation paths of such waves, both underground and over the Earth surface, are considered. A method based on the delay of reception between slow underground electromagnetic waves and waves which travel in the atmosphere at about the light speed is proposed in order to estimate the distance of the source of electromagnetic precursors from the observing station and, hence, to locate the source by means of a network of stations.

RIASSUNTO

In questo lavoro vengono presentati e discussi alcuni meccanismi sull'origine dei precursori elettromagnetici che ci si attende vengano generati molto prima di un terremoto a causa dei processi di microfratturazione delle rocce. Viene poi descritto l'ampio spettro di frequenze dei segnali elettromagnetici prodotti dalle oscillazioni smorzate dei dipoli causate dal processo di microfratturazione. Viene successivamente studiata la propagazione delle onde elettromagnetiche a bassa frequenza nelle bande ELF ed ULF di questo spettro, facendo riferimento alle proprietà elettriche delle rocce che costituiscono la litosfera. Vengono infine considerate le caratteristiche ed i possibili percorsi di propagazione di tali onde, sia nella litosfera, sia sopra la superficie terrestre. Viene proposto un metodo, basato sul ritardo nella ricezione tra le onde che si propagano a velocità relativamente

bassa nella terra e quelle che viaggiano nell'atmosfera praticamente alla velocità della luce, per valutare la distanza della sorgente dei precursori sismici dalla stazione di osservazione e quindi localizzare la sorgente per mezzo di una rete di stazioni.

PAROLE CHIAVE: *PRECURSORI DEI TERREMOTI, SEGNALI SISMICI ELETTROMAGNETICI, BANDE ELF ED ULF, CAMPI ELETTROMAGNETICI.*

KEY-WORDS: *EARTHQUAKES PRECURSORS, SEISMIC ELECTROMAGNETIC SIGNALS, ELF AND ULF BANDS, ELECTROMAGNETIC FIELDS.*

1. INTRODUCTION

The occurrence of earthquakes is associated with the release, in a short time interval, of a large quantity of energy coming from a confined volume below the Earth surface.

The linear dimensions of the focal region in most earthquakes is of the order of few kilometres or even less, while, in large magnitude earthquakes, may be greater. The focal region may be approximated, for the purposes of the present work, to a source of spherical waves or of cylindrical, waves if one of the dimensions predominates over the others. The centre of the focal region, referred to as the focus, is normally, for shallow shocks, at depths less than 60 km which is about only 1% of the Earth radius, although a small number of earthquakes have greater focal depths. This is in agreement with the consideration that most ordinary earthquakes appear to be originated above the Mohorovicic discontinuity, which is placed at depths from about 30 to 60 km. Intermediate shocks originate at depths between 60 and 300 km, while deep shocks originate at depths greater than 300 km, with a maximum depth recorded of about 720 km. While deep and intermediate shocks are limited to the circum-Pacific belt and to the trans-Asiatic belt (GUTENBERG, 1954), the region which extends from Asia Minor to Italy is usually interested mainly by shallow shocks; besides, strong earthquakes are observed in the subduction region of the Hellenic arc.

The purposes of the present paper are: i) to discuss an hypothesis on the possible mechanisms which could give rise to electromagnetic waves from the focal region well before the appearance of shock waves, ii) to describe the

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