

Icequake Focus in Antarctica

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How to cite this paper: Buchachenko, A. and Hayakawa, M. (2025) Icequake Focus in Antarctica. *Open Journal of Earthquake Research*, 14, 165-171.
<https://doi.org/10.4236/ojer.2025.144010>

Received: July 23, 2025

Accepted: November 4, 2025

Published: November 7, 2025

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Abstract

Enigmatic radio signals recently discovered and emitted by the Antarctic ice have been attributed to the hypothetic existence of a new, previously unknown elementary particle. This article suggests an alternative explanation; it considers the ice mass as a giant solid body similar to the earthquake (EQ) focus, in which micro-cracks are generated under anisotropic deforming compression. The electric discharge of the cracks, like the mini-capacitors, is accompanied by the generation of electromagnetic waves. The enigmatic radiation indeed imitates and mimics the electromagnetic activity of the EQ focus, the phenomenon well known in EQ physics. It implies that icequake focus is hidden in the Antarctica.

Keywords

Icequake, Antarctica, Neutrinos, Electromagnetic Radiation, Micro-Cracks

1. Introduction

Recently, a sensational report about the observation of unusual and mysterious radio signals emitted by the ice of Antarctica has been published [1]. These signals were detected by ANITA (Antarctic Impulsive Transient Antenna) instruments mounted on balloons high above the Antarctica and designed to detect radio waves from cosmic rays entering the atmosphere and reflected by ice. The purpose of these experiments is to gain insights into cosmic events (in particular, the birth of neutrinos) by analyzing radio signals reaching the Earth.

It seemed to be mysterious that the detected radio waves were not reflected from the ice as expected, but came from the ice itself [1]. The authors are right, because they have pointed out that these anomalous, enigmatic signals cannot be cosmic and

have nothing to do with neutrinos; otherwise, they would have to pass through rock and ice before reaching the detector, which would make it undetectable, as it would be absorbed by the rock. The purpose of this article is to suggest an alternative source of such anomalous radio waves, eliminating their mystery.

2. Earthquake (EQ) Focus as a Generator of Micro- and Radio-Waves

First of all, it should be realized that Antarctic signals are similar in nature to those emitted by any EQ focus as a giant lithospheric mechanically stimulated chemical macro-reactor, whose energy is created by anisotropic deformation caused by tectonic movements and stresses [2]. The long history of seismology is full of observations, irrefutably exhibiting the relation between electromagnetic and seismic events. Extensive and highly convincing studies of magneto-seismicity, *i.e.* the relationship between microwaves and seismicity, have been carried out by many authors [3]-[13]. These observations certify two facets of magneto-seismicity: they identify EQ focus first, as a microwave generator, as an emitter, and secondly, as a microwave receiver. Here, the emphasis will be on the first facet.

The EQ focus is a giant lithospheric mechano-chemical reactor, in which preparation of the EQ starts on the atomic level: dissociation of chemical bonds, both covalent and ionic, generation of dislocations, their motion and coalescence in microscopic cracks accompanied by shear micro-displacements. It is a key paradigm irrefutably formulated by Sornette [14]: it is not possible to get a reasonable description of an EQ if one forgets about the chemical processes occurring at the smallest scale. The preparation of an EQ and its triggering proceeds on the atomic level and, therefore, in order to control an EQ, it is reasonable to rely on the atomic scale.

The energy in the EQ focus is created by anisotropic deformation induced by tectonic motion and stress; it is accumulated and stored mostly in the dislocations trapped by impurities in crystal lattice, by neighboring dislocations or crystal interfaces. This energy is finally transformed into cracks; their opening can generate electric discharges between the edges of crack, like between the plates of capacitor. The growing crack was shown by direct measurements to transfer charges from 10^{-7} to 10^{-5} Cu per crack, and the moving crack generates electromagnetic field of power of 10^{-20} - 10^{-17} W [15]; it means that the EQ focus is indeed electromagnetic emitter.

The well-known phenomenon of rheological explosion, which occurs under shear deformation of strongly compressed solids and which seems to imitate an EQ, was shown to generate radio-frequency radiation in the range of 60 - 100 MHz [16]. The direct observation of electromagnetic emission, induced by micro fracturing, was performed by Molchanov *et al.* [17]. It is worth to remind that the cracks created by destruction of crystals, besides electromagnetic emission, also generate luminescence (tribo-luminescence) as well as X- and γ -rays and even neutrons [18]. Possibly, the generation of these cracks induces infrasound and micro-trembling of

ground, which is the reason of anomalous animal behavior and which is considered to be one of the forecasting factors of approaching an EQ.

3. Electromagnetic Signals as the EQ Precursors

Numerous observations unambiguously demonstrate that the EQ focus is an emitter of electromagnetic radiation, which spans a broad spectral range. The microwave pulses emitted by focus are suggested to consider as an indication of the “ripening” EQ focus, as a precursor of the coming and expectative catastrophe, as a means to forecast an EQ [19] [20]. Low-frequency electromagnetic signals observed before strong EQs were described by Rokityansky *et al.* [21] [22], in particular, before the disastrous 2011 Tohoku EQ.

The summarizing collection of electromagnetic fields generated by EQs was presented by Johnston [23]; similarly, the records of electromagnetic emission from the powerful Asian EQs are summarized by Li *et al.* [24]. The precursory signature effects of the Kobe EQs were also revealed [25]-[28]; similar signature effects of the Guam and Izu EQs were detected and described [29] [30]. Anomalous radio propagation before and after the 2011 Tohoku EQ demonstrated strong ionospheric disturbances triggered by the EQ appearing in the oblique ionograms; they show very clear signature of the wave-shape-trace. An oblique ionogram was observed at 04:45 UTC on 11 March 2011, one hour before the 2011 Tohoku EQ. This slopy-shape-trace is considered as the pre-seismic ionospheric precursor [31].

All these observations unambiguously evidence that the electromagnetic emission accompanying mechanical evolution of the EQ focus is the forecasting factor to foresee an EQ [32].

The idea of the EQ focus as a coherent electromagnetic emitter is suggested [33] [34]. It elucidates enigmatic properties of the electromagnetic voice of the focus: its emission is not continuous, it occurs periodically, in flashes, which are structured as the pulses occurring in bursts; the electromagnetic activity increases starting approximately two weeks before the quake and becomes very weak or completely disappears one day before the quake (gap of silence). The mechanism of coherency starts with electric discharge of any mini-crack as a mini-capacitor, generating electromagnetic wave; the latter induces discharges of other cracks, multiplying the amplitude of the wave and creating the pulse of seismic electromagnetic signal. It is avalanche-like mechanism of coherency, which transforms even weak electromagnetic signals into the intensive electromagnetic seismic flashes.

4. Glacial EQs

Numerous observations clearly show that the anisotropic deformable solids, in which cracks are created, are the source of electromagnetic signals. There are physical reasons to consider the Antarctic ice mass as the similar compressed, anisotropic deformed ice macro-reactor. The micro-cracks created within it gener-

ate radio waves; namely these signals are detected by ANITA devices. In this sense, the Antarctic ice mass is like a “living” EQ focus. Evidently, the electromagnetic activity of the ice sheets, induced by brittle ice deformation [35], seems to be in principle similar to that of rock deformation. Glacial EQs (icequakes) refer to a type of seismic event with the magnitude of about 5 resulting from the ice deformation events. The majority of glacial EQ activities can be seen in the late summer and are found in Antarctica, Alaska, and Greenland [36]. Glacial EQs are moderate seismic events that occur mostly when ice flowing to the ocean from large glaciers, or ice sheets, breaks off (calves). They were discovered in 2003 by Ekström and coworkers as an anomalous signal that was teased out of the records of the Global Seismographic Network. Since glacial EQs produce large amplitude and long-period waves that deviate from traditional tectonic EQ activity, glacial EQs require different monitoring methods. Additionally, glacial EQs differ from tectonic EQs by lasting longer; for example, a tectonic EQ with a magnitude of 5 may last 5 seconds, while a glacial EQ with a magnitude of 5 may last 30 seconds. Current and past global seismic data are analyzed using an EQ detection algorithm explained in a 2006 paper by Ekstrom [37].

It was pointed out [38] that the last decades witnessed a great interest in glacier seismology. The seismic signals from a wide range of glacier-related processes fill a broad band of frequencies from 10^{-3} to 10^2 Hz and magnitudes from M3 to M7, providing a new view on fundamental processes in the cryosphere. These observations also offer a foundation for understanding ongoing environmental changes and for future monitoring of ice bodies [39]-[44]. And then, it is clear that the observation of mysterious radio signals, emitted by the ice of Antarctica [1], is an event significant for geophysics and seismology. It shows that the ice of Antarctica is alive, that it is in the state of dynamic deforming compression, which is accompanied by electric discharge of micro-cracks and generation of electromagnetic waves; it discloses new areas of research in the geophysics of the ice continent.

5. Conclusion

The evident similarity in the electromagnetic activity of Earth and glacial EQs convinces that the signals emitted by Antarctic ice are not enigmatic; they have nothing to do neither with new elementary particle nor with revision of Standard Model. They are induced by functioning of the ice Antarctic plate. The enigmatic radiation, discovered by ANITA, implies that in the ice of Antarctica, the icequake focus exists.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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