Electromagnetic-Wave Radiations due to the Possible Plate Slip at the Central Shizuoka Earthquakes and to the Island Diastrophism and Volcanic Eruptions in Miyake Islands

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Abstract

Anomalous electromagnetic-wave radiations were detected by the developed high sensitive receiver of order of pT/root hertz at the ELF band of 17Hz and 223Hz in the cases of central Shizuoka earthquakes and of the volcanic eruption in Miyake Islands, central Japan. The radiations were due to the possible plate slip in the central Shizuoka M5.1 earthquakes in April 2001 and due to the diastrophism of islands and to the Miyake volcanic eruption in Summer of 2000. The observed anomalies were well corresponding with the striking events.

1. Radiation due to possible plate slip

Vertical magnetic flux of 17Hz was observed at an electromagnetic (EM) observation site in Ohigawa in the middle part of Shizuoka, central Japan, one month prior to the middle Shizuoka M5.1 earthquake that occurred on April 3, 2001. The observation site recorded a smoothed step-like increase in radiation that was two to three times greater than the amplitude of the ordinary receiving noise. The increase in radiation lasted for one month preceding the earthquake and continued for about six months through October 2001 after the earthquake, accompanied by a swarm of earthquakes. The earthquakes tended to occur when the radiation abruptly decreased. Based on these observations, we inferred that the radiation was related to slip phenomena in the seismogenic zone of the Tokai Slab of the Philippine Sea Plate. In connection with the radiation mechanism, we herein propose a model due to increased thermal agitation noise that appeared on the surface of the earth.

1.1. General sketch of anomalous radiation and related earthquakes

In this paper, we discuss the anomalous radiation observed at the Ohigawa observation site by using magnetic flux sensors of 17Hz and 223Hz. The radiation pattern was quite different from that ordinary obtained. The radiation showed a smoothed increase in the baseline as the background noise level increased. Anomalous radiation was detected especially by the 17Hz sensor but not by the 223Hz sensor. The reason was because the Ohigawa observation site is very near the mouth of the Ohigawa River and also near the seashore (only 200m away). Therefore, a highly conductive layer exists immediately underneath the surface of the earth and the radiation from the deep source area was absorbed by it.

A medium-scale earthquake with a magnitude of M5.1 occurred on April 3, 2001 for the first time in the Naka-Kawane area in the middle of Shizuoka. The earthquake took place when the radiation that had increased to about three times the ordinary level began to decrease after the increased level lasted for one month. Following the earthquake, the radiation decreased to half of the increased level and the decreased level lasted for two weeks. The radiation again increased to a high level. After 22 days following recovery of the radiation back to a high level, severe burst radiation exceeding 10 times the ordinary level continued for about two weeks. Then, a chain of earthquakes of M3.8 (depth = 40km), 4.8 (40km), 4.1 (30km), 4.3 (40km) and 3.9 (40km) occurred in 4 days in the same Naka-Kawane area 3 days after the radiation decreased to the ordinary level. After it, increase and decrease in the radiation were repeated for about 40 days at a shorter cycle of one to three days. Then, severe burst radiation started at a lower level and lasted for about six days and a swarm of earthquakes occurred at the river mouth as a new event. Approximately 35 unfelt earthquakes took place within 6 days with the exception of one that registered M3.1 (depth=19km). The severe burst

radiation lasted for about 22 days and then high and low level radiation was again repeated for one and a half months. The radiation has returned to the ordinary level since September 24, 2001.

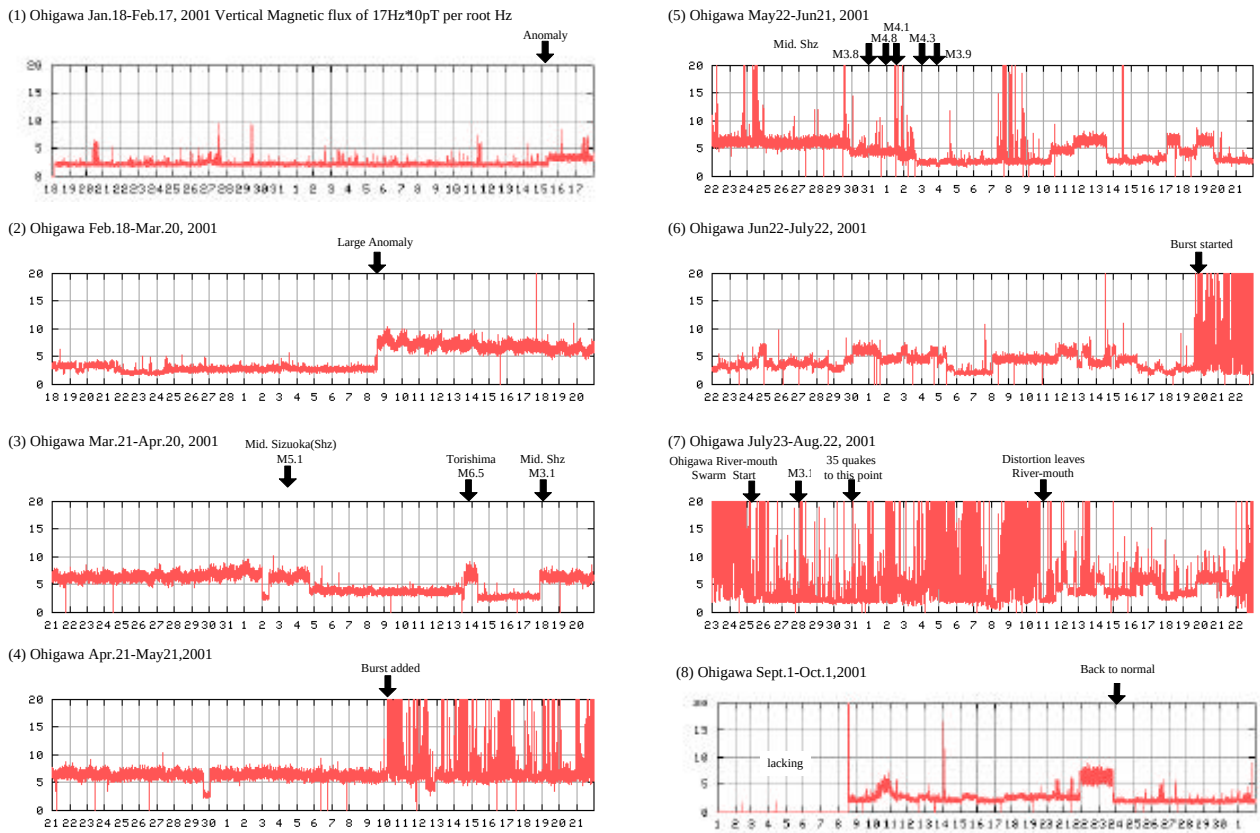

Fig 1. Ohigawa 17Hz vertical magnetic flux radiation of 150s integration for seven months period of January 18 to August 22, 2001

1.2. Study of the observed data in pursuit of a possible plate slip mechanism

After having analyzed the data observed in connection with the radiation, some noteworthy facts as described below have been made known. (1) Occurrence of earthquakes tends to follow EM radiation. (2) Earthquakes occur around the time when a marked decrease or change in the increased level of radiation takes place. (3) There are three types of radiation. (a) The first is radiation that is smoothly maintained at an increased level without large variations. (b) The second is burst radiation diametrically opposed with strong intensity and violent fluctuations. (c) The third is smooth radiation consisting of a chain of step functions with variable amplitudes and time intervals.

Based on these facts, we assumed that radiation is related to a possible plate slip mechanism. When a plate slip takes place, the surface of the plate is heated up by frictional. The heated surfaces of the rocks are activated by free electrons that are thermally agitated. Electron movement is coupled with movement of free electrons on the surface of the earth through electrostatic induction. The coupling force passes through the rocks as a dielectric substance between the conductive electrons. Therefore, the receiver detects the increased noise due to the deep electron agitation. Since the noise consists of many electrons resulting from wide area, the amplitude is smooth. The available noise power is given by kTeB, where Te is the equivalent temperature of the ambient environment. Another candidate for the increased noise could be any compensating current produced by conductive modulation through tectonic pressure exerted by the crust movement. However, the noise must contain more variations of the cause since the compensating current is proportional to the derivative of pressure change.

It has been determined that the radiation increases as plate slip occurs, and conversely, when the plate slip is forced to cease by any cause, plate stress increases, thereby triggering earthquakes.

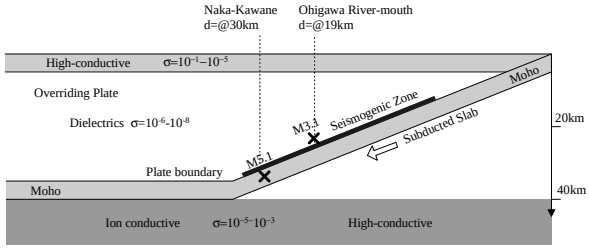

Fig 2. Subduction profile of Tokai slab and the model of electric conductivity of crust.

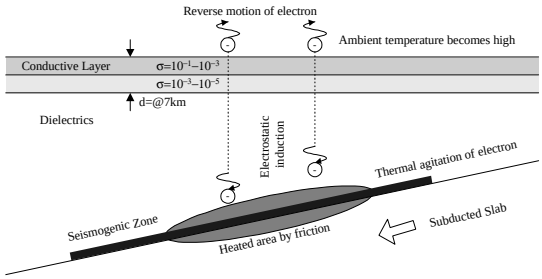

Fig 3. Model of correspondence of slip to electromagnetic radiation

2. Radiations due to Volcanic Eruption

2.1. Unzen Volcanic Eruption

Observations in Unzen started in December 1991 and the receiver had a high sensitivity of 0.025pT per root Hertz for 6-s integration time and 0.125pT per root Hertz for 150-s at the observation frequency of 223Hz with a free space wavelength of about 1,300km. The receiver consists of a three-axial loop coil antenna that is sensitive to magnetic fields. Magnetic field observation was much more stable than in the electric field, because of low wave impedance in the near field, that is, the distance from the site to the volcano and/or earthquake preparing area is generally set closer than the observation wavelength. By the end of 1992, the volcano showed a clear decline in lava supply, a collapse of the dome and less frequent earthquakes, following severe activities for one and a half years from the time the first dome was formed on May 20, 1991. It was believed that the activity would cease by early 1993. Similarly, we detected decreasing radiation signals from the volcano. Therefore, we were able to clearly identify newly generated radiation owing to new ascending lava movement. At that time, our vertical magnetic sensor started to record small but clearly peculiar anomalies. Eventually, the anomalies were followed by the 10th and 11th dome formations about 40 and 75 days later, respectively. The time difference between the anomalies and the dome formation corresponded well with the passing time of lava at the summit. There were no other remarkable activities during the period until the dome formation. About 800m below, it was confirmed that an aquifer about one kilometer thick was present and the ascending speed of the magma was estimated to be approximately 20m per day after passing the aquifer. The anomalous radiation was considered to correspond with the passage of magma across the aquifer zone. We assumed that the vertical flux anomaly was due to conductivity anomaly of rock distortion propagated at a measuring spot 4.5km away from the center by the penetration of magma[4].

2.2 Miyake Volcanic Eruption

A large 10cm-a-day diastrophism of the crust was experienced between Kozu and Niijima islands during the Izu-Miyake volcanic eruptions in Japan on August 3-4, 2000. The diastrophism was detected through GPS observation. The seismometer also complied with a swarm of earthquakes at this time. Our electromagnetic wave data observed at 223Hz at the Omaezaki site, about 110km and 150km northwest of the Kozu and Miyake islands, respectively, detected a clear anomalous magnetic flux radiation that corresponded well with the changes of the seismographic and GPS data. Similar radiation was received for about one week preceding the big volcanic eruption experienced on August 18, 2000. These observations indicate that the electromagnetic wave monitoring system has the potential to monitor and/or warn of volcanic activity, and the facts disclose one of the radiation mechanisms of electromagnetic waves emitted from the earth[2].

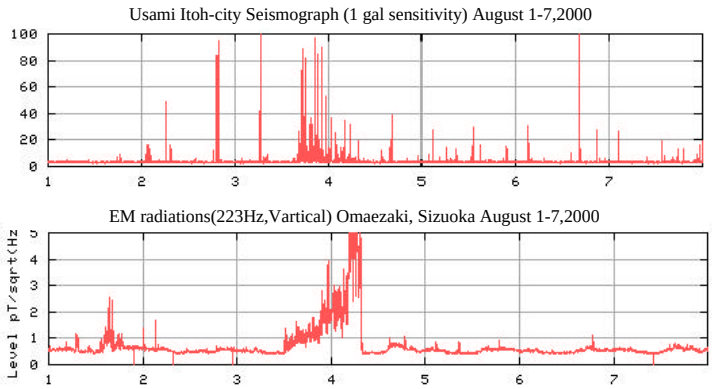

Fig. 4 Earthquakes and anomalous EM radiations when a large 10cm-a-day diastrophism was experienced between Kozu and Niijima islands on August 3-4, 2000.

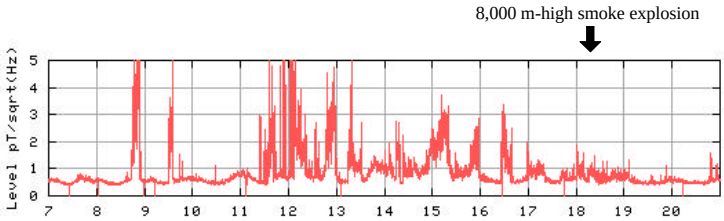

Fig. 5 Severe EM (223Hz vertical) radiations preceded for about ten days to the Miyake-islands 8,000-high smoke explosion on on August18, 2000.

Conclusion

The observed EM radiations in ELF band of 17Hz and 223Hz corresponded with the striking events of earthquakes, the diastrophism of islands and the volcanic eruption. This work was supported by Grant-in-Aid for Scientific Research (A) (1) 11305031 of the Ministry of Education, Culture, Sports, Science and Technology of Japan.

References

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