# Detection Of Earthquake Magnetic Precursors Candidates

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*Abstract* - **A new approach is developed to find a source of pre-EQ ULF electromagnetic activity of lithospheric origin. For separation and localization of EQ magnetic precursors a new polarization ellipse technique has been developed to process the measurements data acquired from 3-component magnetometers.**

*Keywords* - **magnetic, precursors, earthquake, detection, magnetometer.**

## I. INTRODUCTION

Short-term earthquake (EQ) prediction, despite intensive efforts in last half a century, still remains unattainable though numbers of promising leads and directions are indicated. Many physical phenomena are believed to develop before EQ – gases emanation from within the fault zones, raise of underground water level, tectonomagnetic fluctuations etc. The anomalous electromagnetic (EM) emission in ultra low frequency (ULF) band (0.001-10 Hz), was often observed before the EQ and recently is considered as potential precursor for short-term EQ prediction. This observational conviction is further reinforced from the suggestions that mechanical deformations or microfracturing in the impending focal zones may give rise to pre- and/or co-seismic EM emission in ULF band due to one or more of the following factors: (1) movement of conductive medium in the Earth's permanent magnetic field (inductive effect); (2) displacements of boundaries between high and low conductive crustal blocks; (3) electrokinetic effect; (4) piezoelectric or piezomagnetic effects and (5) microfracture electrification. The ULF EM field attenuates rather weakly in crust and thus can be detected at large distances up to 100-150 km.

## II. MAGNETIC PRECURSORS AS MAIN CANDIDATE FOR EQ MONITORING

The practical detection and application of precursory EM signals for real time EQ prediction continue to be challenging due to several problems: (i) intensity of anticipated seismo-EM signals in ULF band is very low, (ii) difficulty of discrimination of weak seismo-EM signals from the background natural EM fields of ionospheric/magnetospheric origin and (iii) the problem of precursor source localization or, at least, determination of azimuth direction to the source zone. Very often these problems are aggravated by short time of precursor existence (less than 5 minutes). With the availability of very sensitive induction type 3-component magnetometers with high suppression of man-made interference (will be described in the report), the high quality recording of magnetic data in ULF bands has greatly improved. For the second problem solution, polarization analysis incorporating the ratio $S_Z/S_H$ ($S_Z$ and $S_H$ are the spectral intensities of vertical and horizontal magnetic field components) is found effective, at least partially, in distinguishing seismo-EM signals from geomagnetic field fluctuations. The formulations of principal component analysis and fractal approach have also been used with some success in isolating components of extra-terrestrial and seismotectonic origin in magnetic field records. Towards the third problem - identification of source location or its direction - the phase difference as well as amplitude difference techniques between pair or more observation points, so-called gradiometric method, is advanced. However a space derivative of magnetic field is very unstable at low signal-to-noise ratio and gives a big error in the estimation of source direction. Very promising in the direction-finding problem for seismo-EM precursors is an application of the polarization ellipse technique, where the major axis behavior is investigated (goniometric method). This technique allows determination of trends in azimuth angle of anomalous ULF signal and possibly area of EQ epicentre.

A new approach is developed to find a source of pre-EQ ULF electromagnetic activity of lithospheric origin [1]. For separation and localization of EQ magnetic precursors a new polarization ellipse technique has been developed to process the measurements data acquired from 3-component magnetometers. The polarization ellipse is formed by the magnetic field components at the measurement station, in selected narrow frequency bands. It is shown that the calculations based on polarization ellipse parameters from at least two distant points allow successful discrimination of seismo-electromagnetic signals from the natural background ULF signals of ionospheric origin.

## III. CONCLUSION

The theoretical approach, observation method and obtained results are discussed. It is shown that the proposed method allows reliable detection of shallow EQ precursors. Also the specially developed for EQ-related ULF signals monitoring instrumentation is presented and its parameters are given. This work was partially supported by STCU grant 5501.

## REFERENCES

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