Advances of alternating EM field for earthquake monitoring in China

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The paper summed the progress of the alternating EM field technique for earthquake monitoring and prediction after 1966 when Xingtai earthquake in Hebei province occurred, expounded the theoretical basement on electromagnetic field for this method, outlined new developed CSELF technique and the experimental examples and the study using satellite EM technologies, and introduced the new data processing and data mining techniques used for massive data (big data).

The study, entitled "Advances in alternating electromagnetic field data processing for earthquake monitoring in China", was published in *Science China Earth Sciences*.2015, 58: 172-182. Professor ZHAO Guoze and his group from State Key Laboratory of Earthquake Dynamics, Institute of Geology, China Earthquake Administration and Associate Professor BI Yaxin from University of Ulster, UK wrote this paper.

China is one of the countries which suffered the most earthquake disaster and paid the great attention on the various techniques including EM methods used in earthquake monitoring and prediction with expensing huge manpower and material resources. The alternating EM field technique had a development lag relative to the traditional electric and magnetic methods. Great a lot observations, however, show that the alternating EM field technique should be one of subjects in which a breakthrough is first made for earthquake prediction and could obtain more abundant information. The amount of observation data exponentially increases, by even orders of magnitude, so it is imperative to develop suitable and effective methods for processing and analyzing

the influx of big data.

The powered Control Source Extremely Low Frequency (CSELF, 300~0.1Hz) technique is found and applied. It consists of a great powered alternating EM signal transmitter in which emission line(s) of dozens to hundreds kilometers long laid on the high crustal resistivity regions and an observation network within a thousands-km distance around the transmitter. Within this network, all stations simultaneously measure the same EM signals emitted by the transmitter and capture possible EM anomalies related to earthquakes. To enhance the S/N ratio, we proposed a two-step self-adaptive technique, which has been tested on actual observed data and demonstrated effective for the data analysis, e.g., the EM spectra and apparent resistivities. The software of "wavelet maxima" method was designed and used in analysis of EM data observed by ground stations and satellite NOAA showing that possible anomalous information in time domain, frequency domain or space can be obtained from the different angles.

CSELF method can observe not only the crustal resistivity and its change but also electro-magnetic fields and their changes. It can not only receive the artificial signals from powered transmitter but also measure natural EM signals. The true stereoscopic monitoring on the earthquake anomalies will be realized if the satellite observation is combined.