Statistical analysis of AETA geo-acoustic signal based on Fractal Theory

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Geo-acoustic signal is one promising precursor phenomena for short-term earthquake prediction. Our team developed a system named AETA which can observe the electromagnetic disturbance and geo-acoustic signal. We have deployed more than 221 observation stations in China and acquired much data in past 3 years. In previous observation, we found that the geo-acoustic signal is quiet most of time. However, when some fluctuation happened, seismic events also happened before or in the days of following in many cases. In order to verify this specific correlation between geo-acoustic and seismicity, we conducted statistical analysis on geo-acoustic data (GD).

In this paper, AETA stations which were installed before 1th Jan 2018 and has more than 10 seismic events within 200km around were chosen. The number of stations is 101. We extract features of geo-acoustic signal by Fractal dimension (FD) which is a method to describe the chaos degree of data. Then mark the anomalies of FD feature by sliding interquartile algorithm. In the end, we use Superposed Epoch Analysis (SEA) to test the statistical correlation between geo-acoustic anomalies and seismicity.

The statistical studies show that for 56 stations, more than half of the chosen stations (55.45%), there is a statistical correlation between geo-acoustic and seismicity. Their anomalies were more likely to appear before and after earthquakes within ±15 days which is demonstrated by the days of anomalies exceeding random_mean+2σ. Among these stations, 36 stations which is 62.5% of 56 stations, exceed the significant level before the earthquake. This means somehow AETA effectively captured the pre-seismic geo-acoustic signal, which is important for us to do earthquake prediction research.

Sometimes the impact of background noise on geo-acoustic signal is too strong to be ignored and quite different in different stations. This explains why some stations may not perform well in SEA, but we believe that seismic signal will be extracted from AETA by multiple signal processing methods. In future, we will improve the recognition rate of seismic anomalies for each station by suppressing the noise, with the increase in the amount of AETA data and the successive deployment of AETA stations over the world.