Development of an automatic hypocenter location system for dense seismic observation(1)

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1. Introduction Iio (2011) points out that the detailed study of fault structure requires seismic observation composed of ten thousand of stations. The number of seismic stations increases year by year, and seismic observation installing thousand stations (Matsumoto 2015) began to be carried out. Such large-scale seismic observation is expected to bring a new finding but also asks the development of automatic arrival time picking technique with accuracy required for the new finding. The present study develops accurate automatic hypocenter location system for a large scale seismic observation.

2. Removal of wrong hypocenter locations We use continuous waveform data recorded in a seismic observation having about 800 seismographs in the area of about 30 km square in Tottori Prefecture. It is difficult in general to install all observation points to a place with low noise in a case of seismic observation which sets a large number of stations in a narrow area. Because of the large number of observation points including noisy stations, there are cases that wrong hypocenters are located by several tens stations which pick artificial noise or some phases from small seismic events occurring at distant areas as P or S wave. We calculated origin times by the use of P and S arrivals in Wadachi diagram and computed the standard error of origin time determination. As a result, we found that values of the standard errors are larger than 0.5 sec for wrong located events and smaller than 0.3 sec for events located correctly. Therefore, we removed events with standard error of origin time larger than 0.5. It was shown that the rate of wrong hypocenter location becomes less than 1% by putting this removal algorithm.

3. P wave polarity picking We used two kinds of waveforms for the polarity reading; 1) Output of 2nd-order high-pass filter with cutoff frequency of 2 Hz, 2) waveform of a 10th-order AR filter with passing a 1st-order low-pass filter. The polarity reading was adopted when polarity is read by either of these two kinds of waveforms. For the polarity reading, we use parameters of 1) S / N ratio before and after the P wave arrival, 2) Ratio of the first peak amplitude to the noise amplitude, 3) The maximum amplitude toward opposite direction to the first peak before the P wave arrives, 4) Same with 3) but after P wave arrival, and 5) The maximum amplitude in 1 second from P wave. For setting of above parameters, we checked the result of automatic readings and searched for events which were not read, or erroneously read. Then, change parameters of polarity reading so that these events are correctly read. We repeated this procedure for about 100 times. By this tuning, the number of polarity reading increased by about 50%.

4. Testing result Testing of automatic picking is made using five month continuous waveform data. Number of located events in and near seismic network is 2100 and number of picked P and S wave arrival times are 408,000 and 411,000. The average travel time residuals of P and S waves were 0.089 and 0.079 seconds, respectively. The number of polarity reading is 124,000.

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