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Full-waveform location methods in microseismic monitoring operations

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Microseismic monitoring became a common operation in many seismological and industrial (Oil&Gas especially) applications, and in the last decade a significant effort has been spent to develop or improve methodologies able to perform seismological analysis for weak events at a local scale. This effort was accompanied by the improvement of monitoring systems, resulting in an increasing number of large microseismicity catalogs. The interest in microseismicity, involving a synergy among different scientific communities, is in part due to their occurrence both in consequence of natural processes in active regions, swarm areas, hydrothermal and volcanic environments, but also in relation to human activities, e.g., in proximity of mining areas, geothermal systems, oil and gas fields, and water reservoirs. The analysis of microseismicity is challenging, because of the large number of recorded events often characterized by a low signal-to-noise ratio. A significant limitation of the traditional location approaches is that automated picking is often done on each seismogram individually, making little or no use of the coherency information between stations. In order to improve the performance of the traditional location methods, in the last year, different full waveform location methods have been proposed. These methods exploits the coherence of the waveforms recorded at different stations and do not require any automated picking procedure. The main advantage of this methods relies on their robustness even when the recorded waveforms are very noisy. On the other hand, like any other location method, the location performance strongly depends on the accuracy of the available velocity model. When dealing with inaccurate velocity models location results can be affected by large errors. Here we will present an overview on the main full waveform location methods focusing on a new relative waveform stacking method which inherits all the advantages of the full waveform location methods without its main drawback. This method is less dependent on the knowledge of the velocity model and presents several benefits, which improve the location accuracy: 1) it accounts for phase delays due to local site effects, e.g. surface topography or variable sediment thickness 2) theoretical velocity model are only used to estimate travel time within the source volume, and not along the entire source-sensor path. After successfully testing the method with synthetic data, we applied it to a real microseismicity dataset.