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Advanced Real-time Monitoring for Natural and Induced seismic sequences

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Detailed information on the spatio-temporal migration of seismic activity within earthquake sequences provides an important seismotectonic context for rapid hazard evaluation of natural and induced seismicity. For those applications, monitoring the migration of seismicity requires the precise location of (micro-)seismic hypocenters and robust magnitude estimation in real-time. We propose a comprehensive approach to automatic monitoring of seismicity sequences, extending a standard regional seismic network infrastructure to the denser local network configuration. There are key advantages to using existing and operational seismic network infrastructure are: we can 1) use existing well-established, reliable and continually exercised procedures to manage data and metadata and create catalogues; and 2) effectively combine the existing background network with a more dense temporary micro-seismic monitoring network . Simply applying standard network monitoring tools at regional level to micro-seismicity sequences is not sufficient. Seismicity sequences are, in fact, often characterised by vigorous seismicity with very short inter-event times and many events can be missed or wrongly characterised. Furthermore it is challenging to accurately locate and quantify seismicity at magnitudes well below the traditional resolution of regional networks.

We outline an approach where we integrate multiple new features tailored to micro-seismicity sequences within a routine monitoring approach using a standard automatic software framework, SeisComP3. We improve detection capability and absolute location tools and we perform a systematic comparison in term of performance among modern waveform-based methods and the pick-based detection and location methods (SCAUTOLOC and SCANLOC) implemented within the SeisComP3 software package. We also use a near real-time template matching based detector and relative magnitudes to lower the magnitude of detection and provide robust micro-seismic magnitudes in order to better understand emerging seismicity patterns. Finally, we implement cross-correlation based, near real-time double-difference relative relocation techniques to provide rapid information on the spatio-temporal migration of seismic activity. Results from this infrastructure can significantly improve real-time hazard assessment for natural and induced seismicity. In this study, we describe the framework and the components of the proposed infrastructure and present preliminary applications to different seismic sequences in Switzerland.