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An improved low-frequency earthquakes catalogue in the vicinity of the late-interseismic central Alpine Fault, Southern Alps, New Zealand

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Characterising the seismicity associated with slow deformation in the vicinity of the Alpine Fault may provide constraints on the state of stress of this major transpressive margin prior to a large (≥M8) earthquake. Here, we use recently detected tectonic tremor and low-frequency earthquakes (LFEs) to examine how slow tectonic deformation is loading the Alpine Fault toward an anticipated large rupture. We initially work with a continous seismic dataset collected between 2009 and 2012 from an array of short-period seismometers, the Southern Alps Microearthquake Borehole Array. Fourteen primary LFE templates, found through visual inspection within previously identified tectonic tremor, are used in an iterative matched-filter and stacking routine. This method allows the detection of similar signals and establishes LFE families with common locations. We thus generate a 36 month catalogue of 10718 LFEs. The detections are then combined for each LFE family using phase-weighted stacking to yield a signal with the highest possible signal to noise ratio. We found phase-weighted stacking to be successful in increasing the number of LFE detections by roughly 20%. Phase-weighted stacking also provides cleaner phase arrivals of apparently impulsive nature allowing more precise phase picks. We then compute non-linear earthquake locations using a 3D velocity model and find LFEs to occur below the seismogenic zone at depths of 18-34 km, locating on or near the proposed deep extent of the Alpine Fault. To gain insight into deep fault slip behaviour, a detailed study of the spatial-temporal evolution of LFEs is required. We thus generate a more extensive catalogue of LFEs spanning the years 2009 to 2016 using a different technique to detect LFEs more efficiently. This time 638 synthetic waveforms are used as primary templates in the match-filter routine. Of those, 38 templates yield no detections over our 7-yr study period. The remaining 600 templates end up detecting between 370 and 730 events each totalling ∼310 000 detections. We then focus on only keeping the detections that robustly stack (i.e. representing real LFEs) for each synthetic template hence creating new LFE templates. From there, we rerun the match-filter routine with our new LFE templates. Finally, each LFE template and its subsequent detections form a LFE family, itself associated with a single source. Initial testing shows that this technique paired up with phase-weighted stacking increases the number of LFE families and overall detected events roughly thirtyfold. Our next step is to study in detail the spatial and temporal activity of our LFEs. This new catalogue should provide new insight into the deep central Alpine Fault structure and its slip behaviour.