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Detecting sub-millimeter fault slip using extensometers in the forearc and volcanic zone of northern Chile

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Due to resolution, the detection of small-scale slip rates along faults is often limited using standard geologic and geodetic techniques. While modern geodetic methods, such as InSAR, GPS and precise EDM allow deformation measurements in the centimeter range, geological records often suggest displacement rates at the millimeter or even sub-millimeter scale. Although displacements may be very small, their detection is considered important for understanding transient and time dependent tectonic processes. Current strain-meters, however are costly and difficult to install, limiting more extended surveys. In order to evaluate the rate and timing of small displacements, we utilize creepmeters in the forearc and volcanic zone near Mejillones Peninsular and San Pedro Volcano, northern Chile. The installed creepmeters consist of extendable Invar rods connected to a potentiometer and high precision temperature sensors, installed at 1 m depth across potentially active faults or fractures. Upon changes of the length standard, a change in the electric resistance results, allowing to resolve sub-millimeter displacements. Performing a spectral analysis we observe a regular oscillating signal correlated to lunar and solar tides. Signals different to those oscillations may have tectonic causes, such as observed following the magnitude Mw7.7 Nov 14 2007 Tocopilla earthquake in northern Chile. Sub-millimeter displacements along a reactivated fault correlate with M~5 aftershocks at distances as far as 200 km. This suggests that creepmeter studies are capable of studying the temporal correlation and interaction of tectonic and volcanic signals at large distances.